

SPRING
EDITION

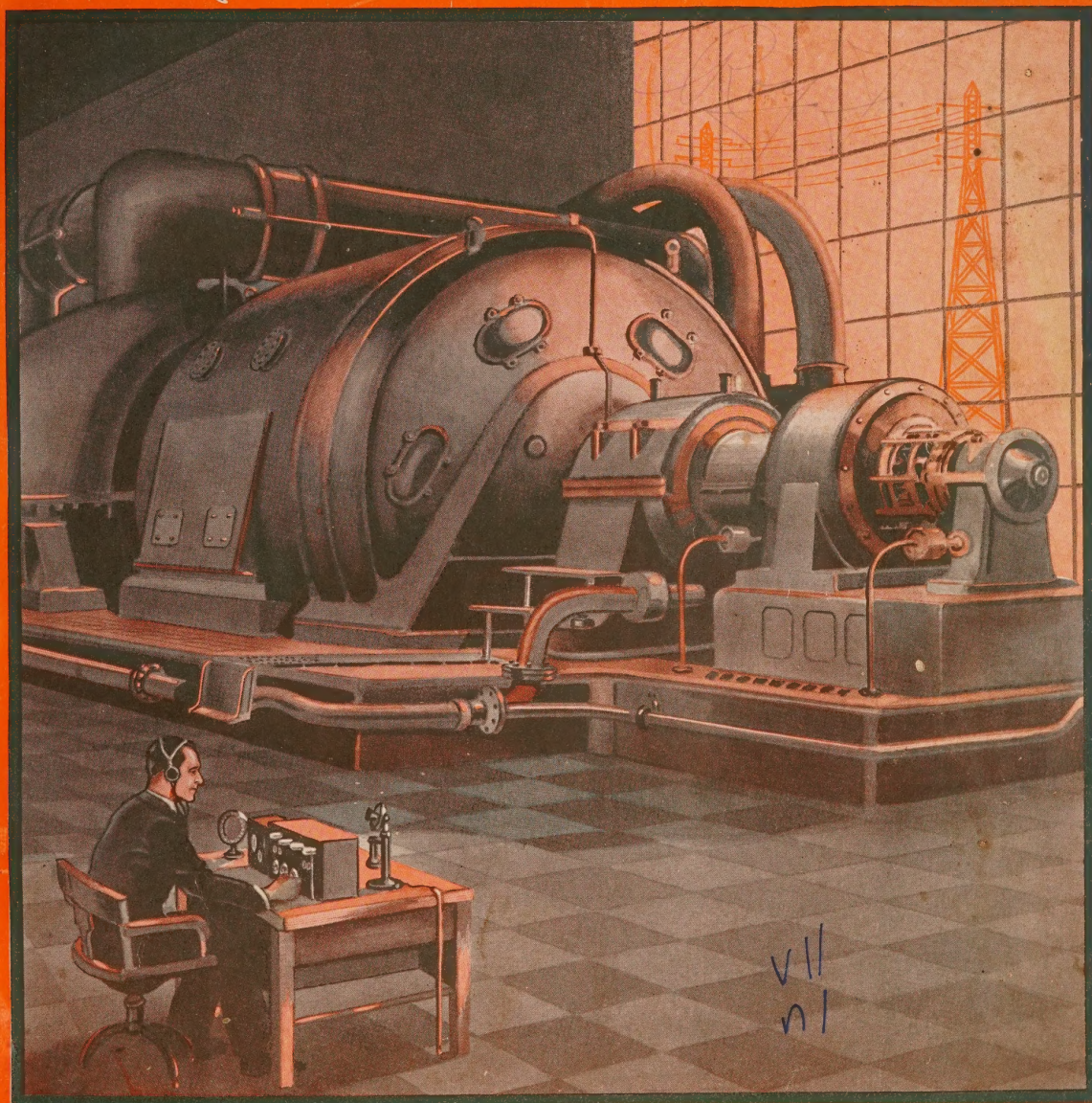
CITIZENS

50¢

Radio Call Book Magazine

N.S.E.

and TECHNICAL REVIEW



SERVICE - REPAIR - ENGINEERING
POWER AMPLIFICATION - TELEVISION

4 of the 40 Easy Ways to Make \$3⁰⁰ an Hour

In Your Spare Time
in **RADIO**

Below
are a few of
the reports
from those now
cashing in on the
"40 Easy Ways"

THE four plans shown are but a sample of the many ways in which our members are making \$3.00 an hour upwards, spare time and full time, from the day they join the Association. If you want to get into Radio, have a business of your own, make \$50 to \$75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

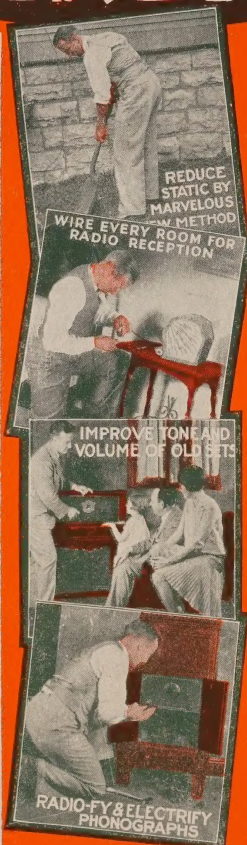
The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the \$600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.



Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean \$50 to \$75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. RCB-1 Chicago, Illinois



Cleares \$3,000.00 Frank J. Deutch, Pa.—"Since joining the Association I have cleared nearly \$3,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow our easy ways of making money."

\$1,100.00 in 6 Weeks J. R. Allen, Calif.—"Have done over \$1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

\$25.00 a Week Spare Time N. J. Friedrich, N. Y.—"I have averaged \$25.00 a week for the last 7 months even though I am not a graduate but just learning."

Training Lands Him Job R. C. Kirk, N. C.—"Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below now. You'll always be glad you did.

Radio Training Association of America
Dept. RCB-1, 4513 Ravenswood Ave., Chicago, Ill.

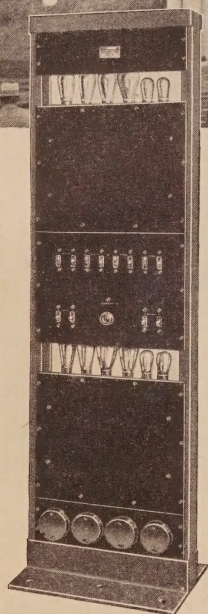
Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

Name _____

Address _____

City _____

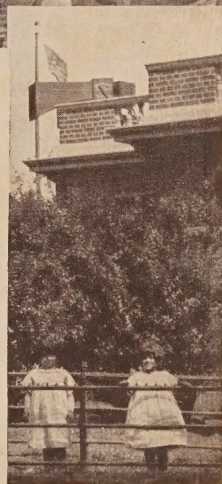
State _____



2-V PAM 19

New York Parks are PAM Equipped

In Central Park, New York, programmes such as Goldman's Band, speeches originating in the bandstand, etc., are picked up and amplified by a PAM amplifier similar to that illustrated at the left and fed over wires to twenty-five municipal parks in other sections of the city.



One of
New York's Parks

In each of these other parks is installed a 2V PAM-19 shown above which supplies reproducers located at proper points, thus permitting simultaneous quality reproduction at widely separated points.

The parks in your city are logical prospects for a similar type of equip-

ment. Have you seen your park authorities?

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM amplifiers will be sent upon receipt of 10 cents in stamps to cover postage. When writing ask for bulletin No. CRCB7.

Main Office:
Canton, Mass.

Samson Electric Co.

MEMBER
RMA

Manufacturers Since 1882

Factories at Canton
and Watertown, Mass.

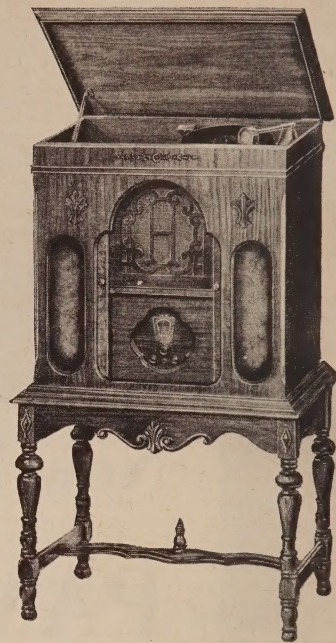
THE ULTIMATE RECEIVER

EXCELLO RADIO

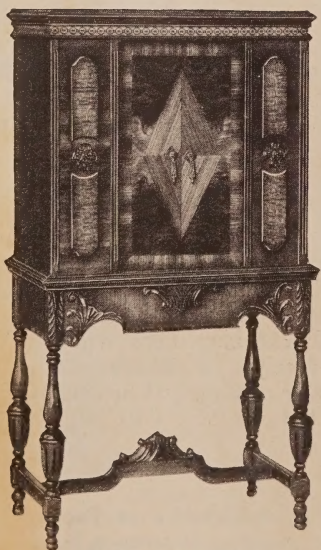
SCREEN GRID RADIO
HIGH GRADE CABINETS
DYNAMIC SPEAKER
POWER DETECTION
PUSH PULL AUDIO
SELECTIVITY
SENSITIVITY
TONE QUALITY
POWER

are required for

EXCELLENT REPRODUCTION



Style No. R-154



Style No. R-166

EXCELLO Radio presents a combination of Chassis, Cabinet and Speaker representing the highest engineering skill.

Excello Consoles have for years held the highest place in the cabinet field, and Excello radio is now offered in a choice of fifteen styles of Excello Consoles ranging from low priced cabinets to some of the finest examples of the cabinet makers' art. It is also offered in Radio-Phonograph Combinations.

Mail the attached coupon for full particulars.

EXCELLO PRODUCTS CORPORATION

4820-28 West 16th St.

Cicero, Illinois

EXCELLO PRODUCTS CORPORATION

4820-28 W. 16th St., Cicero, Illinois

Please send full information on Excello Radio and Consoles.

☐ Dealer

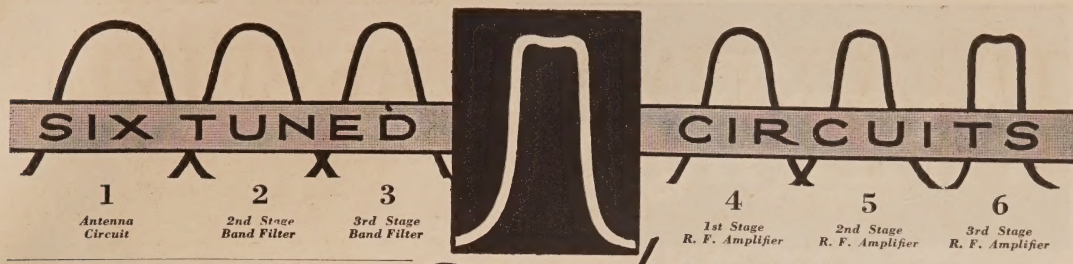
☐ Set Builder

☐ Fan

Name.....

Street.....

Town..... State.....



Tuned **BAND-FILTER**

**FLAT-TOP — STRAIGHT-SIDE
10-KILOCYCLE SELECTIVITY**

HAMMARLUND once again has put over a screen-grid, band-filter radio with six tuned circuits, so amazingly efficient that professional radio men by the score are building it for their own use.

The "HiQ-29" was a startling revelation, but in the words of Al. Jolson, "You ain't heard nothin' yet" like the "HiQ-30" performance—or the "HiQ-30" tone.

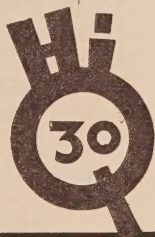
It is the only circuit that makes screen-grid tubes really do a day's work and the marvelous "HiQ-30" power amplifier with push-pull '45's takes all they can give it.

Pre-selected signals — ten-kilocycles apart — with no side-band cutting means *Selectivity* with a capital "S" and T-O-N-E that talks.

The easiest of all "H-Q's" to build, too, with complete, factory-wired and tested units. No adjustments — no troubles. It percolates from the start. A.C. or battery chassis fits standard cabinets, or your choice of nine special "HiQ-30" cabinets including phonograph combinations, \$139.50 to \$1175 complete, less tubes.

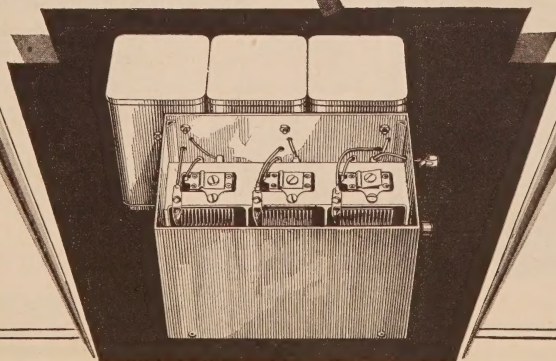
You should have a copy of the 48-page "HiQ-30" Manual. Price 25c. Use the coupon.

**WORLD'S
PREMIER**



**CUSTOM
RADIO**

Complete Factory-Built Units—Wired and Tested, ready to install.



HAMMARLUND-ROBERTS, Inc.
Dept. CE1, 424-438 W. 33rd St.,
New York.

Enclosed 25c (stamps or coin)
for "HiQ-30" Manual.

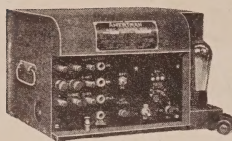
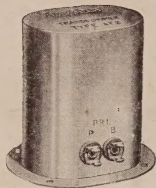
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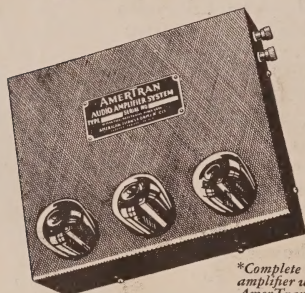
AMERTRAN

TRADE MARK REG. U.S. PAT. OFF.

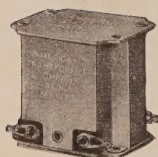
Type AF-8 Audio Transformer—Either 1st or 2nd stage audio. Turn ratio $3\frac{1}{2}$ — List Price \$6.00



*AmerTran ABC Hi-Power Box—500 volts DC plate voltage, current up to 110 ma; AC filament current for all tubes for any set. Adjustable bias voltages for all tubes. Price, east of Rockies—less tubes—\$130.00.

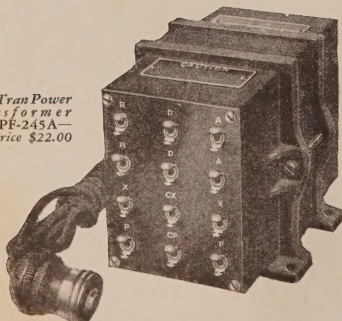


*Complete 2 stage audio amplifier with first stage AmerTran De Luxe for UX 227 AC and second stage AmerTran Push-Pull for two 171 or 210 power tubes. Operates with 450 volt AmerTran Hi-Power Box. Price east of Rockies—less tubes—\$80.00.



AmerTran De Luxe Audio Transformer—List Price \$10.00. Type 151—Between one input and two output tubes—List Price \$15.00

AmerTran Power Transformer Type PF-245A—List Price \$22.00



*Licensed under patents of the Radio Corporation of America and associated companies for radio, amateur, experimental and broadcast reception.

Quality RADIO PRODUCTS

AmerTran Audio and Power Transformers and Amplifiers are designed for those who truly appreciate fine quality in radio reception.

Weakness in the audio system in many receiving sets results in failure to deliver full richness of tone along the entire scale. AmerTran Radio Products perfect the audio system and reproduce music and the speaking voice in true tone (without distortion at any volume) just as broadcast in the studio.

For detailed information write for the following Bulletins:

Bulletin 1084 — AmerTran De Luxe Audio Transformer

Bulletin 1087 — AmerTran Audio Transformer Type AF-8

Bulletin 1088 — AmerTran Power Transformer Type PF245A

Bulletin 1076-A — AmerTran Hi-Power Box Type 21-D

Bulletin 1075-A — AmerTran Push-Pull Amplifier Type 2-AP

Bulletin 1065 — The Complete AmerTran Line.

AmerTran Quality Radio Products are sold by all good dealers, or direct if they cannot supply you.

AMERICAN TRANSFORMER COMPANY

Transformer builders for over 29 years

172 Emmet Street, Newark, N. J.

AMERICAN TRANSFORMER COMPANY

172 Emmet Street, Newark, N. J.

Please send me the following Bulletins. (Check (✓) those you want).

Bulletin 1084 () ; 1087 () ; 1088 () ; 1076-A () ; 1075-A () ; 1065 () .

Name.....

Street and No.....

Town..... State.....

C.B.-1-30

I Will Train You at Home to Fill a Big-Pay Radio Job



Here's the PROOF



\$375 One Month in Spare Time

"Recently I made \$375 in one month in my spare time installing, servicing, selling Radio Sets."

Earle Cummings,
18 Webster St.,
Haverhill, Mass.

Jumped from \$35 to \$100 a Week

"Last week I had the pleasure of earning \$110 servicing and selling Radio sets. I have made as high as \$241 in two weeks. Before entering Radio I was making \$35 a week. It is certainly great sport to do this kind of work."

J. A. Vaughn,
4202 Arsenal St.,
St. Louis, Mo.



\$450 a Month

"I work in what I believe to be the largest and best equipped Radio shop in the Southwest and also operate KGFI. I am averaging \$450 a month."

Frank M. Jones,
922 Guadalupe St.,
San Angelo, Tex.

If you are earning a penny less than \$50 a week, I send for my book of information on the opportunities in Radio. It's FREE. Clip the coupon NOW. A flood of gold is pouring into this new business, creating hundreds of big pay jobs. Why go along at \$25, \$30 or \$45 a week when the good jobs in Radio pay \$50, \$75, and up to \$250 a week. My book, "Rich Rewards in Radio," gives full information on these big jobs and explains how you can quickly become a Radio Expert through my easy, practical, home-study training.

Salaries of \$50 to \$250 a Week Not Unusual

Get into this live-wire profession of quick success. Radio needs trained men. The amazing growth of the Radio business has astounded the world. In a few short years three hundred thousand jobs have been created. And the biggest growth of Radio is still to come. That's why salaries of \$50 to \$250 a week are no unusual. Radio simply hasn't got nearly the number of thoroughly trained men it needs. Study Radio and after only a short time land yourself a REAL job with a REAL future.

You Can Learn Quickly and Easily in Spare Time

Hundreds of N. R. I. trained men are today making big money—holding down big jobs—in the Radio field. Men just like you—their only advantage is training. You, too, can become a Radio Expert just as they did by our new practical methods. Our tested, clear training, makes it easy for you to learn. You can stay home, hold your job, and learn quickly in your spare time. Lack of education or experience are no drawbacks. You can read and write. That's enough.

Many Earn \$15, \$20, \$30 Weekly on the Side While Learning

My Radio course is the famous course "that pays for itself." I teach you to begin making money almost the day you enroll. My new practical method makes this possible. I give you SIX BIG OUTFITS of Radio parts with my course. You are taught to build practically every type of receiving set known. M. E. Sullivan, 412 73rd Street, Brooklyn, N. Y. writes: "I made \$720 while studying." Earle Cummings, 18 Webster Street, Haverhill, Mass.: "I made \$375 in one month." G. W. Page, 1807 21st Ave., Nashville, Tenn.: "I picked up \$935 in my spare time while studying."

Your Money Back If Not Satisfied

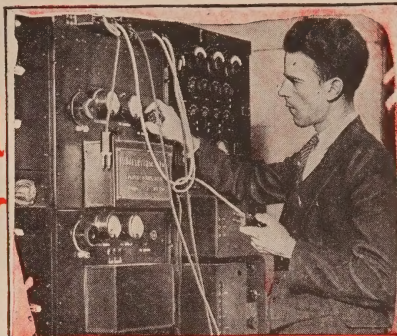
I'll give you just the training you need to get into the Radio business. My course fits you for all lines—manufacturing, selling, servicing sets, in business for yourself, operating on board ship or in a broadcasting station—and many others. I back up my training with a signed agreement to refund every penny of your money if, after completion, you are not satisfied with the course I give you.

Act Now—NEW 64- Page Book Is FREE

Send for this book of Radio information. It won't cost you a penny. It has put hundreds of fellows on the road to bigger pay and success. Get it. Investigate. See what Radio has to offer you, and how my Employment Department helps you get into Radio after you graduate. Clip or tear out the coupon and mail it RIGHT NOW.

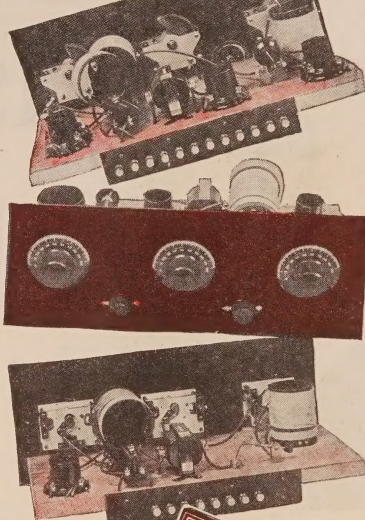
J. E. SMITH, President
Dept. OAE
National Radio Institute
Washington, D. C.

**RADIO
NEEDS
TRAINED
MEN!**



**You can build
100 circuits with
the six big outfits
of Radio parts
I give you**

3 of the 100 you can build



**Find out quick
about this
practical way
to big pay**



Mail This FREE COUPON Today

J. E. SMITH, President
Dept. OAE, National Radio Institute
Washington, D. C.

Dear Mr. Smith: Kindly send me your big book, "Rich Rewards in Radio," giving information on the big-money opportunities in Radio and your practical method of teaching with six big outfits. I understand this book is free, and that this places me under no obligation whatever.

Name.....Age.....
Address.....
City.....State.....
Occupation.....

**Employment Service to all Graduates
Originators of Radio Home Study Training**

Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

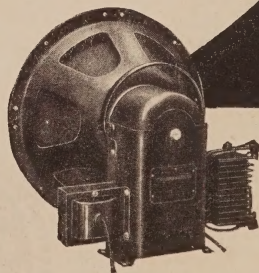
IF IT ISN'T A MAGNAVOX IT ISN'T A DYNAMIC

(With a bow to Kodak)

Only Magnavox can build and sell a DYNAMIC Speaker, by authority of the United States Patent Office.

Only Magnavox customers and dealers can employ the selling force inherent in that word DYNAMIC.

Only Magnavox owners can enjoy true-to-life dynamic REALISM, and a life-



Models 401, 403 and 405
12 $\frac{1}{4}$ " high, 12" wide,
8 $\frac{1}{4}$ " deep, 10 $\frac{1}{2}$ " cone

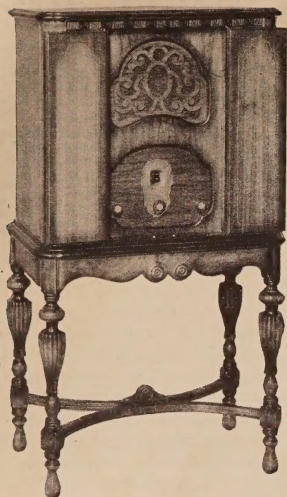
time guarantee—made possible by the new Magnavox X-Core construction.

THE MAGNAVOX COMPANY

Originators of the dynamic loud speaker in 1911

Factory and Pacific Sales OAKLAND, CALIFORNIA
Factory and Sales East of the Rockies . . . CHICAGO, ILLINOIS

The NEW Nelson AC Receiver A Masterpiece in Radio

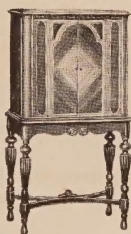


**NELSON AC RECEIVER IN PALMER
CONSOLE**

This very attractive model appeals to those seeking for something different in a fine radio receiver. Slightly modernistic in design, it embodies good taste and graceful lines. Walnut construction throughout, with French doors of diamond matched Oriental walnut set off by carefully selected walnut panels. Equipped with large Jensen DC electro-dynamic speaker.

LIST PRICE \$185, without tubes

This receiver fully described in this issue.



Uses nine tubes in all, five of them in the radio frequency circuit! **Power Detection** that eliminates the noisy intermediate stage! **Push-Pull Audio**, using the new 245 type tubes! Genuine Jensen Electro-Dynamic Speaker—the big 11" size, to take the tremendous power of the highly efficient Technidyne circuit, and reproduce everything, bass or treble, music or voice, in the true, realistic tone re-created by the instrument itself. Here you have **Power . . . Range . . . Tone!**

Note These Features:

AC OPERATION

Practical AC operation assures consistent performance. Oversize air-cooled power transformer, with unique voltage control device makes for more efficient operation and longer tube life.

HUMLESS

Use of the new AC heater type tubes insures freedom from hum and all extraneous noises, which in combination with DC dynamic speaker and large capacity Mershon Filter Condenser means an unusually fine quality of reproduction.

SELECTIVITY

Completely shielded four-in-line tuning condenser and scientifically accurate coils, used in a highly efficient pre-selection circuit, permits a degree of selectivity which easily separates powerful locals and brings in distant stations with the punch of a local.

SUPER-SENSITIVITY

Power detector and improved radio frequency amplifying stages completely eliminates possibility of oscillation, yet maintains 100% sensitivity. Circuit is designed to provide equal amplification over the entire waveband.

APPEARANCE

Consoles are especially designed to incorporate beauty and good taste. Only the finest hardwoods and best craftsmanship enter into their construction. Lustrous hand-rubbed finish and authentic styles fit into any decorative scheme.

PRICE

Range of prices and styles sufficient to meet with the individual taste and ideas of each user. Large scale production allows price to be kept far below that of any other receiver of equal quality and performance.

POWER DETECTION

Tuned power detector circuit operating at high efficiency, is in keeping with latest engineering practice. Due to impossibility of overloading detector circuit, more volume and purer tone are a matter of course.

"245'S IN PUSH-PULL

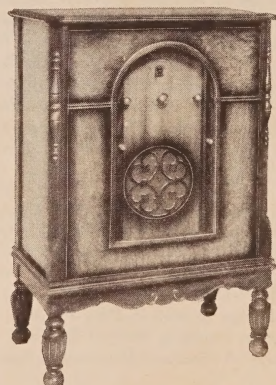
Two 245 super power amplifying tubes in the output stage have an output far in excess of a 250 power tube, giving an unsurpassed quality of reproduction which represents the utmost in tonal refinement.

TONE

Large oversize transformers, well designed audio and radio frequency circuits, and a large Jensen dynamic speaker, each carefully matched, all contribute to the wonderful tone quality, characteristic of this fine receiver.

TREMENDOUS VOLUME

Perfection in the audio frequency amplifying stages coupled with the large unobstructed output of the detector circuit makes possible an ultimate power output of auditorium volume, and from concert volume to a whisper at will.



**NELSON AC-30 RECEIVER IN MORTON
CONSOLE**

A moderately priced console receiver in a lowboy model of distinctly beautiful and graceful lines. Finest walnut and other hardwoods used throughout. Genuine walnut burl overlay with straight grained Oriental walnut instrument panel. Carefully matched diagonal grain sliding doors. Rich hand rubbed finish that fits in any decorative scheme whatever. Equipped with large Jensen electro-dynamic speaker.

LIST PRICE \$170 without tubes

DEALERS WANTED

Responsible dealers everywhere will find it to their advantage to know more about the new Nelson AC Radio. Its furniture excellence and true-tone performance makes it a self seller that stays sold. Write today for complete details and dealer's proposition. Desirable territory is still open.

NELSON ELECTRIC COMPANY

508 South Dearborn Street

Chicago, Ill.

"We Ship Faster"

NELSON ELECTRIC COMPANY 508 SOUTH DEARBORN STREET, CHICAGO, ILLINOIS.

Please send me full information regarding the New Nelson AC Receiver, together with details on Dealer Franchise, etc.

Name

Address

☐ DEALER ☐ SERVICE MAN ☐ CUSTOM SET BUILDER

Citizens Radio Call Book Magazine

AND TECHNICAL REVIEW

Registered in U. S. Patent Office
Established 1921

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Executive Offices:
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Member Audit Bureau of Circulations

F. A. HILL, Editor
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JANUARY, 1930

Published January, March, September, November

Vol. 11, No. 1

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Citizens Radio Call Book Magazine is published four times a year and is on sale approximately the first of January, March, September and November. Subscription price \$1.75 per year in U. S. A. Canada and Foreign \$2.00 per year, payable in advance. Single copies 50 cents. Remit by check, draft, or P. O. order. No foreign stamps or coins accepted. Mail subscriptions to 508 So. Dearborn Street, Chicago. We will not be responsible for cash sent for subscriptions unless registered.

Advertising Representatives:

Chicago—A. B. Mills, 508 So. Dearborn St. Wabash 1901.
New York—(Branch Office)—154 W. 42nd St., Room 1125. Wisconsin 5681.

Entered as second class matter November 15, 1923, at the Postoffice at Chicago, Illinois, under the act of March 3, 1879.

Distribution of Broadcast Chains by Cities

	Chain	Kilo-cycles		Chain	Kilo-cycles		Chain	Kilo-cycles
Akron, Ohio			Hartford, Conn.			Portland, Me.		
WFJC	National	1450	WTIC	National	1060	WCSH	National	940
Asheville, N. C.			Hot Springs, Ark.			Portland, Ore.		
WWNC	Columbia	570	KTHS	National	1040	KGW	National	620
Atlanta, Ga.			Houston, Texas			KOIN	Columbia	940
WSB	National	740	KPRC	National	920	Providence, R. I.		
Baltimore, Md.			Independence, Mo.			WTAR	National	890
WBAL	National	1060	KMBC	Columbia	950	WEAN	Columbia	780
WCAO	Columbia	600	Indianapolis, Ind.			Raleigh, N. C.		
Birmingham, Ala.			WFBM	Columbia	1230	WPTF	National	680
WAPI	National	1140	Jackson, Miss.			Richmond, Va.		
WBRC	Columbia	930	WJDX	National	1270	WRVA	National	1110
Boston, Mass.			Jacksonville, Fla.			Roanoke, Va.		
WEEL	National	590	WJAX	National	900	WDBJ	Columbia	930
WBZA	National	990	Kansas City, Mo.			Rochester, N. Y.		
WNAC	Columbia	1230	WDAF	National	610	WHAM	National	1150
Bowmanville, Can.			Kingston, Can.			WHEC	Columbia	1440
CKGW	Columbia	960	CFRB	Columbia	960	Salt Lake City, Utah		
Buffalo, N. Y.			Lawrence, Kan.			KSL	National	1130
WGR	National	550	WREN	National	1220	KBYL	Columbia	1290
WMAK	Columbia	900	Lincoln, Neb.			San Antonio, Texas		
WKBW	Columbia	1470	KFAB	National	770	WOAI	National	1190
Charlotte, N. C.			Little Rock, Ark.			KTSA	Columbia	1490
WBT	National	1080	KLRA	Columbia	1390	San Francisco, Calif.		
Chattanooga, Tenn.			London, Can.			KFO	National	680
WDOD	Columbia	1280	CJGC	Columbia	910	KFRC	Columbia	610
Chicago, Ill.			Los Angeles, Calif.			Schenectady, N. Y.		
WGN	National	720	KECA	National	1430	WGY	National	790
WLIB	National	720	KPC	National	640	Seattle, Wash.		
WENR	National	870	KHJ	Columbia	900	KOMO	National	970
WLS	National	870	Louisville, Ky.			Sioux City, Iowa		
KTW	National	1020	WHAS	National	820	KSCJ	Columbia	1330
KFKX	National	1020	Memphis, Tenn.			Spokane, Wash.		
WCFL	National	1280	WMC	National	780	KHO	National	590
WBO	National	560	Miami Beach, Fla.			KFPY	Columbia	860
WMAO	Columbia	670	WIOD	National	1300	Springfield, Mass.		
WBBM	Columbia	770	Milwaukee, Wis.			WBZ	National	990
WJJD	Columbia	1130	WTMJ	National	620	St. Louis, Mo.		
Cincinnati, Ohio			WISN	Columbia	1120	KSD	National	550
WLW	National	700	Minneapolis, Minn.			KWK	National	1350
WSAI	National	1330	WCCO	Columbia	810	KMOX	Columbia	1090
WKRC	Columbia	550	WRHM	Columbia	1250	St. Paul, Minn.		
Cleveland, Ohio			Montreal, Can.			KSTP	National	1460
WTAM	National	1070	CKAC	Columbia	730	Superior, Wis.		
WEAR	National	1070	Nashville, Tenn.			WEBC	National	1290
WHK	Columbia	1390	WSM	National	650	Syracuse, N. Y.		
Columbus, Ohio			WLAC	Columbia	1490	WFBL	National	900
WAU	Columbia	640	New Orleans, La.			Tacoma, Wash.		
WCAH	Columbia	1430	WSMB	National	1320	KVI	Columbia	760
Council Bluffs, Iowa			WDSU	Columbia	1270	Tallmadge, Ohio		
KOIL	Columbia	1260	New York, N. Y.			WADC	Columbia	1320
Covington, Ky.			WEAF	National	660	Toledo, Ohio		
WCKY	National	1480	WJZ	National	760	WSPD	National	1340
Dallas, Texas			WABC	Columbia	860	Toronto, Can.		
WFAA	National	800	Norfolk, Va.			CKGW	National	690
KRLD	Columbia	1040	WTAR	Columbia	780	Topeka, Kan.		
Davenport, Iowa			Oakland, Calif.			WIBW	Columbia	1300
WOC	National	1000	KGO	National	790	Tulsa, Okla.		
Denver, Colo.			Oil City, Pa.			KVOO	National	1140
KOA	National	830	WLBW	Columbia	1260	Washington, D. C.		
Des Moines, Iowa			Oklahoma City, Okla.			WRC	National	950
WHO	National	1000	WKY	National	900	WMAL	Columbia	630
Detroit, Mich.			KJFF	Columbia	1470	Whitehaven, Tenn.		
WWJ	National	920	Omaha, Neb.			WREC	Columbia	600
WJR	National	750	WOW	National	590	Wichita, Kan.		
WGHP	Columbia	1240	Philadelphia, Pa.			KFH	Columbia	1300
Dupont, Colo.			WFI	National	560	Worcester, Mass.		
KLZ	Columbia	560	WLIT	National	560	WTAG	National	580
Ft. Wayne, Ind.			WCAU	Columbia	1170	Youngstown, Ohio		
WOWO	Columbia	1160	WFAN	Columbia	610	WKBN	Columbia	570
Ft. Worth, Texas			Pittsburgh, Pa.					
WBAP	National	800	WCAE	National	1220			
Harrisburg, Pa.			KDKA	National	980			
WHP	National	1430	WJAS	Columbia	1290			



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Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

American Broadcasting Stations

Station assignments shown in the following pages were made by the Federal Radio Commission. This list is revised from issue to issue and is therefore up-to-the-minute. Initials such as E, C, M, and P denote Eastern, Central, Mountain and Pacific time.

KCRC

1370 kc, Enid, Okla., Champlin Refining Co., 100 w, C.

KDB

1500 kc, Santa Barbara, Calif., Santa Barbara Broadcasting Co., 100 w, P.

KDFN

1210 kc, Casper, Wyo. D. L. Hathaway, 100 w, P.

KDKA

980 kc, East Pittsburgh, Pa., Westinghouse E. & M. Co., 50,000 w, E.

KDLR

1210 kc, Devils Lake, N. D., Radio Electric Co., 100 w.

KDYL

1290 kc, Salt Lake City, Utah, Intermountain Broadcasting Corp., 1000 w, M, "On the Air, Goes Everywhere."

KECA

1430 kc, Los Angeles, Calif., Pacific Development Radio Co., 1000 w, P.

KEJK

710 kc, Beverly Hills, Calif., R. S. MacMillan, 500 w, P.

KELW

780 kc, Burbank, Calif., Earl L. White, 500 w, P, "The White Spot of the San Fernando Valley."

KEX

1180 kc, Portland, Ore., Western Broadcasting Co., 5000 w, P, "A Public Service Necessity."

KFBB

1360 kc, Great Falls, Mont., Buttrey Broadcast, Inc., 500 w, M.

KFBK

1310 kc, Sacramento, Calif., James McClatchy Co., 100 w, P.

KFBL

1370 kc, Everett, Wash., Leese Bros., 50 w, P, "The Voice of Puget Sound."

KFDM

560 kc, Beaumont, Tex., Magnolia Petroleum Co., 500 w, C, "Kall for Dependable Magnolene."

KFDY

550 kc, Brookings, S. D., State College, 500 w, C.

KFEL

920 kc, Denver, Colo., Eugene P. O'Fallon, Inc., 250 w, M, "The Argonaut Station."

KFEQ

680 kc, St. Joseph, Mo., Scroggin & Co., 2500 w, C.

KFGQ

1310 kc, Boone, Iowa, Boone Biblical College, 100 w, C.

KFH

1300 kc, Wichita, Kan., Radio Station KFH Co., 500 w, C, "Kansas' Finest Hotel, in the Very Heart of God's Country."

KFHA

1200 kc, Gunnison, Colo., Western State College of Colorado, 50 w.

KFI

640 kc, Los Angeles, Calif., Earl C. Anthony, Inc., 5000 w, P, "National Institution."

KFIF

1420 kc, Portland, Ore., Benson Polytechnic School, 100 w, P.

KFIO

1230 kc, Spokane, Wash., Spokane Broadcasting Corp., 100 w day, P.

KFIZ

1420 kc, Fond du Lac, Wis., Reporter Printing Co., 100 w, C.

KFJB

1200 kc, Marshalltown, Iowa, Marshall Electric Co., 100 w, C, "Marshalltown, the Heart of Iowa."

KFJF

1470 kc, Oklahoma City, Okla., National Radio Mfg. Co., 5000 w, C, "Radio Headquarters of Oklahoma."

KFJI

1370 kc, Astoria, Ore., KFJI Broadcasters, Inc., 100 w, P.

KFJM

1370 kc, Grand Forks, N. D., University of North Dakota, 100 w, C.

KFJR

1300 kc, Portland, Ore., Ashley C. Dixon & Son, 500 w, P.

KFJY

1310 kc, Ft. Dodge, Iowa, C. S. Tunwal, 100 w, C.

KFJZ

1370 kc, Ft. Worth, Texas, Henry Clay Meacham, 100 w, C.

KFKA

880 kc, Greeley, Colo., Colorado State Teachers College, 500 w, M, Shared.

KFKB

1050 kc, Milford, Kan., KFKB Brdstg. Assn., 5000 w, C, "The Sunshine Station in the Heart of the Nation."

KFKU

1220 kc, Lawrence, Kan., University of Kansas, 1000 w, C, "Up at Lawrence on the Kaw."

KFKX

See under KYW.

KFLV

1410 kc, Rockford, Ill., A. T. Frykman, 500 w, C.

KFLX

1370 kc, Galveston, Texas, Geo. Roy Clough, 100 w, C.

KFMX

1250 kc, Northfield, Minn., Carleton College, 1003 w, C.

KFNF

890 kc, Shenandoah, Iowa, Henry Field Seed Co., 500 w, C, "Known for Neighb' Folks."

KFOR

1210 kc, Lincoln, Neb., Howard A. Shuman, 100 w, C.

KFOX

1250 kc, Long Beach, Calif., Nichols & Warriner, Inc., 1000 w, P, "Where Your Ship Comes In."

KFPL

1310 kc, Dublin, Texas, C. C. Baxter, 15 w, C, "Baxter's Place."

KFPM

1310 kc, Greenville, Texas, The New Furniture Co., 15 w, C, "Biggest Little Ten Watts on the Air."

KFPW

1340 kc, Siloam Springs, Ark., Rev. Lannie W. Stewart, 50 w, C.

KFPY

860 kc, Spokane, Wash., Symons' Investment Co., 500 w, P.

KFQA

See under KMOX.

KFQD

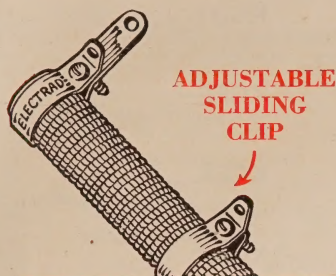
1230 kc, Anchorage, Alaska, Anchorage Radio Club, 100 w.

KFQU

1420 kc, Holy City, Calif., W. E. Riker, 100 w, P.

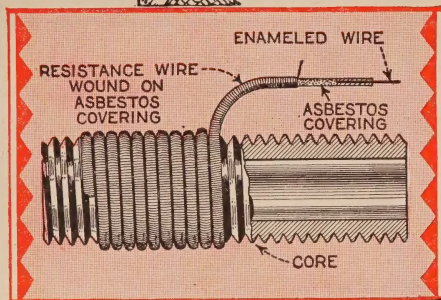
KFQW

1420 kc, Seattle, Wash., KFQW, Inc., 100 w, P, "Gateway to Alaska and the Orient."



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SLIDING
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TRUVOLT Resistances are double-wound. The resistance wire is first wound around an asbestos covered enameled copper core, then around a fire-clay base. Only with this patented winding can be secured the greater air-cooled area which has made "TRUVOLT" a synonym for "PERFECT PERFORMANCE."



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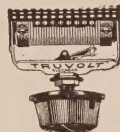
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Fixed types have adjustable sliding clip for quick adjustment. Made in all usual sizes and wattage ratings.

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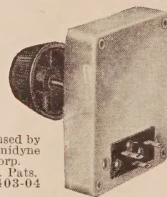
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KFQZ

860 kc, Los Angeles, Calif., Taft Radio & Broadcasting Co., Inc., 250 w, P.

KFRC

610 kc, San Francisco, Calif., Don Lee, Inc., 1000 w, P.

KFRU

630 kc, Columbia, Mo., Stephens College, 500 w, C, "Where Friendliness Is Broadcast Daily."

KFSD

600 kc, San Diego, Calif., Airfan Radio Corp., 500 w, P.

KFSG

1120 kc, Los Angeles, Calif., Echo Park Evan. Assn., 500 w, P, "The Church of the Air."

KFUL

1290 kc, Galveston, Texas, W. H. Ford, 500 w, C, "The City of Perpetual Sunshine."

KFUM

1270 kc, Colorado Springs, Colo., W. D. Corley, 1000 w, M, "Known for Unsurpassed Mountain Scenery."

KFUO

550 kc, St. Louis, Mo., Concordia Theological Seminary, 500 w, C, "The Gospel Voice."

KFUP

1310 kc, Denver, Colo., Fitzsimmons General Hospital, 100 w, M.

KFVD

1000 kc, Culver City, Calif., Los Angeles Broadcasting Co., 250 w, P.

KFVS

1210 kc, Cape Girardeau, Mo., Hirsch Battery & Radio Co., 100 w, C, "The City of Opportunity."

KFWB

950 kc, Hollywood, Calif., Warner Bros. Broadcasting Corp., 1000 w, P.

KFWF

1200 kc, St. Louis, Mo., St. Louis Truth Center, Inc., 100 w.

KFWI

930 kc, San Francisco, Calif., Radio Entertainments, Inc., 500 w, P.

KFWM

930 kc, Richmond, Calif., Oakland Educational Society, 500 w, P, "The Most Good to the Most People."

KFXD

1420 kc, Jerome, Idaho, Service Radio Co., 50 w, M.

KFXF

920 kc, Denver, Colo., Pikes Peak Broadcasting Co., 250 w, M, "The Voice of Denver."

KFXJ

1310 kc, Edgewater, Colo., R. G. Howell, 50 w, M, "America's Scenic Center."

KFXM

1210 kc, San Bernardino, Calif., Lee Bros. Broadcasting Co., 100 w, P, "The Voice of the Orange Empire."

KFXR

1310 kc, Oklahoma City, Okla., Exchange Avenue Baptist Church, 100 w, C.

KFFX

1420 kc, Flagstaff, Ariz., Mary M. Costigan, 100 w, M.

KFYO

1420 kc, Abilene, Texas, T. E. Kirksey, 100 w, C, "Breckenridge, the Dynamo of West Texas."

KFYR

550 kc, Bismarck, N. D., Hoskins-Meyer, 500 w, C.

KGA

1470 kc, Spokane, Wash., Northwest Radio Service Co., 5000 w, P.

KGAR

1370 kc, Tucson, Ariz., Tucson Motor Service Co., 100 w, M, "Way Out on the Desert."

KGB

1330 kc, San Diego, Calif., Pickwick Broadcasting Corp., 250 w, P, "Music for the Sick."

KGBU

900 kc, Ketchikan, Alaska, Alaska Radio & Service Co., 500 w.

KGBX

1370 kc, St. Joseph, Mo., Foster-Hall Tire Co., 100 w.

KGBZ

930 kc, York, Nebr., Geo. R. Miller, 500 w, C, "The Swine and Poultry Station."

KGCA

1270 kc, Decorah, Iowa, Chas. W. Greenley, 50 w, C.

KGCI

1370 kc, San Antonio, Texas, Liberto Radio Sales, 100 w, C, "Radio Sam at San Antonio."

KGCR

1210 kc, Watertown, S. D., Cutler's Radio Broadcasting Service, Inc., 100 w.

KGCU

1200 kc, Mandan, N. D., Mandan Radio Association, 100 w, M, "The Voice of the West."

KGCX

1310 kc, Wolf Point, Mont., First State Bank of Vida, 100 w, M.

KGDA

1370 kc, Dell Rapids, S. D., Home Auto Co., 50 w.

KGDE

1200 kc, Fergus Falls, Minn., Jaren Drug Co., 50 w, C.

KGDM

1100 kc, Stockton, Calif., E. F. Pepper, 50 w.

KGDY

1200 kc, Oldham, S. Dak., J. Albert Loesch, 15 w, C.

KGEF

1300 kc, Los Angeles, Calif., Trinity Methodist Church, 1000 w, P.

KGEK

1200 kc, Yuma, Colo., Bechler Elec. Equip. Co., 50 w, M. Shared.

KGER

1360 kc, Long Beach, Calif., C. Merwin Dobyns, 100 w, P, "The Service Club of the Air."

KGEW

1200 kc, Ft. Morgan, Colo., City of Ft. Morgan, 100 w, P.

KGEZ

1310 kc, Kalispell, Mont., Chamber of Commerce, 100 w, M, "Located in the Switzerland of America—The Beautiful Flathead Valley."

KGFF

1420 kc, Alva, Okla., D. R. Wallace, 100 w, C.

KGFG

1370 kc, Oklahoma City, Okla., Faith Tabernacle Assn., 100 w, C, "The Whole Gospel to the Whole World."

KGFI

1500 kc, Corpus Christi, Texas, Eagle Broadcasting Co., 100 w, C, "The Voice of West Texas."

KGFI

1200 kc, Los Angeles, Calif., Ben S. McGlashan, 100 w, P, "Keeps Good Folks Joyful."

KGFK

1200 kc, Hallock, Minn., Lautzenheiser Mitchell, 50 w, C.

KGFL

1370 kc, Raton, N. Mex., Hubbard & Murphy, 50 w, M.

KGFW

1310 kc, Ravenna, Neb., Otto F. Sothman, R. H. McConnell, 50 w.

KGFX

580 kc, Pierre, S. D., Dana McNeil, 200 w, C.

KGGC

1420 kc, San Francisco, Calif., Golden Gate Broadcasting Co., 50 w, P.

KGGF

1010 kc, Picher, Okla., D. L. Connell, M.D., 500 w.

KGGM

1370 kc, Albuquerque, N. Mex., New Mexico Broadcasting Co., 250 w.

KGHF

1320 kc, Pueblo, Colo., Kitchie & Finch, 250 w, M.

KGHG

1310 kc, McGehee, Ark., Chas. W. McCollum, 50 w.

Announcing

our production of a new short wave radio receiving set—the most outstanding advanced development on the market.

From anywhere to anywhere it brings in the most distant stations.

NEW SHORTWAVE SET

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FRANCISCO

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LONDON

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CALCUTTA

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SHANGHAI

TOKIO

This new Short Wave Receiver design by Charles R. Leutz now places short wave reception on a much more reliable basis. New and original features are included which overcome some of the early difficulties in short wave reception. Instead of adapting ordinary broadcast receiver

parts for short wave work, this new design is made entirely of new parts specially designed for short wave reception and with a complete knowledge of the scientific requirements. The result is short wave performance which sets entirely new standards for distance and reliability.

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Paris, France

KGHI

1200 kc, Little Rock, Ark., Berean Bible Class, 100 w.

KGHL

950 kc, Billings, Mont., Northwestern Auto Supply Co., 500 w, M.

KGHX

1500 kc, Richmond, Tex., Houston Brdcastg. Co., 50 w, C.

KGIO

1320 kc, Twin Falls, Idaho, Radio Broadcasting Corp., 250 w, M.

KGIR

1360 kc, Butte, Mont., KGIR, Inc., 250 w, M.

KGIW

1420 kc, Trinidad, Colo., Trinidad Creamery Co., 100 w, M.

KGIX

1420 kc, Las Vegas, Nev., J. M. Heaton, 100 w.

KGJF

890 kc, Little Rock, Ark., First Church of the Nazarene, 250 w.

KGKB

1500 kc, Brownwood, Tex., Eagle Publ. Co., 100 w, C.

KGKL

1370 kc, San Angelo, Tex., KGKL, Inc., 100 w, C.

KGKO

570 kc, Wichita Falls, Tex., Wichita Falls Broadcasting Co., 250 w, C.

KGKX

1420 kc, Sandpoint, Idaho, C. E. Twiss and F. H. McCann, 15 w, P.

KGO

790 kc, Oakland, Calif., General Electric Co., 7500 w, P.

KGRC

1370 kc, San Antonio, Texas, Eugene J. Roth, 100 w, C.

KGRS

1410 kc, Amarillo, Texas, Gish Radio Service, 1000 w, C. Shared.

KGU

940 kc, Honolulu, Hawaii, Marion Mulrony, Advertising Publ. Co., 500 w, "In the Land of Sunshine, the Future Playground of America."

KGW

620 kc, Portland, Ore., Oregonian Pub. Co., 1000 w, P, "Keep Growing Wiser."

KGY

1200 kc, Lacey, Wash., St. Martins College, 10 w, P, "Out Where the Cedars Meet the Sea."

KHJ

900 kc, Los Angeles, Calif., Don Lee, Inc., 1000 w, P, "Kindness, Happiness, Joy."

KHQ

590 kc, Spokane, Wash., Louis Wasmer, Inc., 1000 w, P, "In the Friendly City."

KICK

1420 kc, Red Oak, Iowa, Red Oak Radio Corp., 100 w.

KID

1320 kc, Idaho Falls, Ida., Jack W. Duckworth, Jr., 250 w, M.

KIDO

1250 kc, Boise, Idaho, Boise Broadcasting Station, 1000 w, P.

KIT

1370 kc, Yakima, Wash., C. E. Haymond, 50 w, P.

KJBS

1070 kc, San Francisco, Calif., Julius Brunton & Sons Co., 100 w, P, "The Voice of the Storage Battery."

KJR

970 kc, Seattle, Wash., Northwestern Broadcasting Co., 5000 w, P.

KLCN

1290 kc, Blytheville, Ark., C. L. Lintzenich, 50 w, C.

KLO

1370 kc, Ogden, Utah, Peery Building Co., 100 w, M.

KLPM

1420 kc, Minot, N. D., E. C. Reineke, 100 w, C.

KLRA

1390 kc, Little Rock, Ark., Arkansas Broadcasting Co., 1000 w.

KLX

1440 kc, Oakland, Calif., Warner Bros., 250 w, P, "The City of Golden Opportunity."

KLX

880 kc, Oakland, Calif., Tribune Pub. Co., 500 w, P, "Where Rail and Water Meet."

KLZ

560 kc, Dupont, Colo., Reynolds Radio Co., Inc., 1000 w, M, "The Pioneer Station of the West."

KMA

930 kc, Shenandoah, Iowa, May Seed & Nursery Co., 500 w, C, "Keeps Millions Advised."

KMBC

950 kc, Kansas City, Mo., Midland Broadcasting Co., 1000 w, C, "Kansas City's Most Powerful Public Service Broadcasting Station."

KMED

1310 kc, Medford, Ore., Mrs. W. J. Virgin, 50 w, P, "See Crater Lake."

KMIC

1120 kc, Inglewood, Calif., Dalton's, Inc., 500 w, P.

KMJ

1210 kc, Fresno, Calif., J. McClatchy Co., 100 w, P.

KMMJ

740 kc, Clay Center, Neb., The M. M. Johnson Co., 1000 w, C, The Old Trusty Station."

KMO

860 kc, Tacoma, Wash., KMO, Inc., 500 w, P.

KMOX

1090 kc, St. Louis, Mo., Voice of St. Louis, Inc., 5000 w, C.

KMTR

570 kc, Hollywood, Calif., KMTR Radio Corp., 500 w, P, "Your Friend in Hollywood."

KNX

1050 kc, Hollywood, Calif., Western Broadcast Co., 50,000 w, P, "The Voice of Hollywood."

KOA

830 kc, Denver, Colo., General Electric Co., 12,500 w, M.

KOAC

550 kc, Corvallis, Ore., Oregon State Agricultural College, 1000 w, P, "Science for Service."

KOB

1180 kc, State College, N. M., N. M. College of Agri. & Mech. Arts, 10,000 w, M, "The Sunshine State of America."

KOCW

1400 kc, Chickasha, Okla., Oklahoma College for Women, 250 w, C.

KOH

1370 kc, Reno, Nevada, Jay Peters, Inc., 100 w.

KOIL

1260 kc, Council Bluffs, Iowa, Mona Motor Oil Co., 1000 w, C, "The Hilltop Studio."

KOIN

940 kc, Portland, Ore., KOIN, Inc., 1000 w, P, "The Station of the Hour."

KOL

1270 kc, Seattle, Wash., Seattle Broadcasting Co., 1000 w, P.

KOMO

970 kc, Seattle, Wash., Fisher's Blend Station, Inc., 1000 w, P.

KOOS

1370 kc, Marshfield, Ore., H. H. Hanseth, 50 w, P.

KORE

1420 kc, Eugene, Ore., Eugene Broadcast Station, 100 w, P.

KOY

1390 kc, Phoenix, Ariz., Nielsen Radio Supply Co., 500 w, M, "Kind Friends Come Back."

KPCB

1210 kc, Seattle, Wash., Wescoast Broadcasting Co., 50 w, P. Shared.

KPJM

1500 kc, Prescott, Ariz., Miller & Klahn, 100 w, M.

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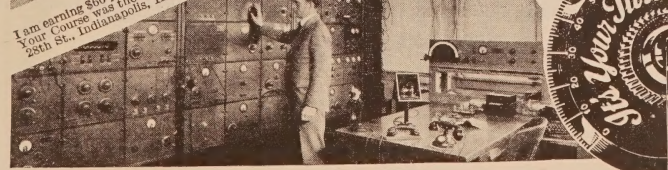
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KPO

680 kc, San Francisco, Calif., Hale Bros. & The Chronicle, 5000 w, P, "The City of the Golden Gate."

KPOF

880 kc, Denver, Colo., Pillar of Fire, Inc., 500 w. M.

KPPC

1210 kc, Pasadena, Calif., Pasadena Presbyterian Church, 50 w, P

KPQ

1210 kc, Seattle, Wash., Wescoast Broadcasting Co., 100 w, P.

KPRC

920 kc, Houston, Texas, Houston Printing Co., 1000 w, C, "Kotton Port Rail Center."

KPSN

1360 kc, Pasadena, Calif., Pasadena Star-News, 1000 w, P.

KPWF

1490 kc, Westminster, Calif., Pacific Western Broadcasting Federation, 5000 w, P.

KQV

1380 kc, Pittsburgh, Pa., Doubleday-Hill Elec. Co., 500 w, E, "The Smoky City Station."

KQW

1010 kc, San Jose, Calif., First Baptist Church, 500 w, P, "For God and Country."

KRE

1370 kc, Berkeley, Calif., First Congregational Church, 100 w, P.

KREP

620 kc, Phoenix, Ariz., KAR Broadcasting Co., 500 w, M, "Phoenix, Where Winter Never Comes."

KRGV

1260 kc, Harlingen, Texas, Valley Radio Electric Corp., 500 w.

KRLD

1040 kc, Dallas, Texas, KRLD, Inc., 10,000 w, C, "Down Where the Blue Bonnets Grow."

KRMD

1310 kc, Shreveport, La., Robert M. Dean, 50 w, C.

KRSC

1120 kc, Seattle, Wash., Radio Sales Corp., 50 w, P.

KSAC

580 kc, Manhattan, Kan., Kansas State Agricultural College, 500 w, C.

KSAT

1240 kc, Ft. Worth, Texas, Texas Air Transport Broadcasting Co., 1000 w, C.

KSCJ

1330 kc, Sioux City, Iowa, Perkins Bros. Co., 1000 w, C.

KSD

550 kc, St. Louis, Mo., Pulitzer Pub. Co., 500 w, C.

KSEI

900 kc, Pocatello, Idaho, KSEI Broadcasting Assn., 250 w, M, "Kummunty Southeast Idaho."

KSL

1130 kc, Salt Lake City, Utah, Radio Service Corp., 5000 w, M, "The Voice of the Inter-mountain Empire."

KSMR

1200 kc, Santa Maria, Calif., Santa Maria Valley R. R. Co., 100 w, P, "The Valley of Gardens."

KSO

1380 kc, Clarinda, Iowa, Berry Seed Co., 500 w, C, "Keep Serving Others."

KSOO

1110 kc, Sioux Falls, S. D., Sioux Falls Broadcasting Assn., 1000 w, C.

KSTP

1460 kc, St. Paul, Minn., National Battery Broadcasting Co., 10,000 w, C.

KTAB

560 kc, Oakland, Calif., Associated Broadcasters, 1000 w, P, "Knowledge, Truth and Beauty."

KTAP

1420 kc, San Antonio, Texas, Alamo Broadcasting Co., 100 w, C, "The World's Biggest Little Station."

KTBI

1300 kc, Los Angeles, Calif., Bible Institute of Los Angeles, 750 w, P.

KTBR

1300 kc, Portland, Ore., M. E. Brown, 500 w, P.

KTBS

1450 kc, Shreveport, La., S. R. Elliott and A. C. Steere, 1000 w, E.

KTHS

1040 kc, Hot Springs, Ark., Chamber of Commerce, 10,000 w, C, "Kum to Hot Springs."

KTM

780 kc, Santa Monica, Calif., Pickwick Broadcasting Corp., 500 w, P, "The Station with a Smile."

KTNT

1170 kc, Muscatine, Iowa, Norman Baker, 5000 w, C, "The Voice of the Iowa Farmers' Union."

KTSA

1290 kc, San Antonio, Texas, Lone Star Broadcast Co., 1000 w, C.

KTSL

1310 kc, Shreveport, La., Houseman Sheet Metal Works, Inc., 100 w, C.

KTSM

1310 kc, El Paso, Tex., W. S. Bledsoe and W. T. Blackwell, 100 w, C.

KTUE

1420 kc, Houston, Texas, Uhalt Electric, 5 w, C.

KTW

1270 kc, Seattle, Wash., First Presbyterian Church, 1000 w, P.

KUJ

1500 kc, Longview, Wash., Columbia Broadcasting Co., Inc., 10 w, P.

KUOA

1390 kc, Fayetteville, Ark., University of Arkansas, 1000 w, C.

KUSD

890 kc, Vermillion, S. Dak., University of South Dakota, 500 w, C.

KUT

1120 kc, Austin, Texas, Kut Broadcasting Co., 500 w, C, "Come to University of Texas."

KVEP

1500 kc, Portland, Ore., Schaeffer Radio Co., 15 w, P.

KVI

920 kc, Tacoma, Wash., Puget Sound Radio Broadcasting Co., 1000 w, P, "Puget Sound Station."

KVL

1370 kc, Seattle, Wash., Arthur C. Bailey, 100 w.

KVOA

1260 kc, Tucson, Ariz., R. M. Riculfi, 500 w.

KVOO

1140 kc, Tulsa, Okla., Southwestern Sales Corp., 5000 w, C, "The Voice of Oklahoma."

KVOS

1200 kc, Bellingham, Wash., KVOS, Inc., 100 w, M.

KWCR

1310 kc, Cedar Rapids, Iowa, Harry F. Paar, 100 w.

KWEA

1210 kc, Shreveport, La., William E. Antony, 100 w, C.

KWG

1200 kc, Stockton, Calif., Portable Wireless Tel. Co., 100 w, P.

KWJJ

1060 kc, Portland, Ore., Wilbur Jerman, 500 w, P, "The Voice from Broadway."

KWK

1350 kc, St. Louis, Mo., Greater St. Louis Broadcasting Corp., 1000 w, C.

KWKC

1370 kc, Kansas City, Mo., Wilson Duncan Broadcasting Co., 100 w.

KWKH

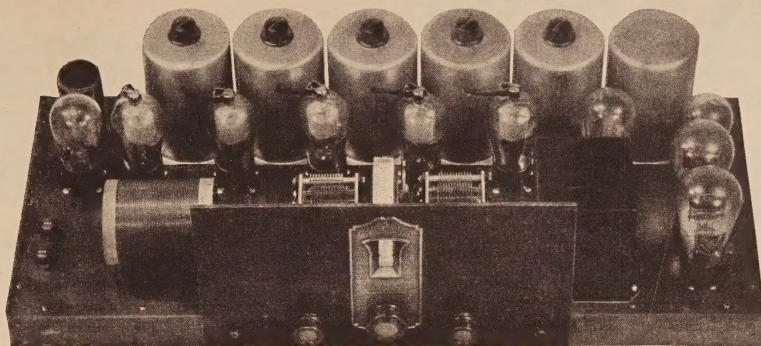
850 kc, Kennonwood, La., W. K. Henderson, 10,000 w, C.

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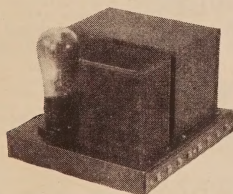
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1270 kc, Decorah, Iowa, Luther College, 100 w, C.

KWSC

1400 kc, Pullman, Wash., State College of Washington, 500 w, P, "The Voice of the Cougars."

KWWG

1260 kc, Greenville, Texas, Chamber of Commerce, 500 w, C, "Good Night, World."

KXA

570 kc, Seattle, Wash., American Radio Tel. Co., 500 w, P.

KXL

1420 kc, Portland, Ore., KXL Broadcasters, Inc., 100 w, P, "The Voice of Portland."

KXO

1200 kc, El Centro, Calif., Irely & Bowles, 100 w, P.

KXRO

1310 kc, Aberdeen, Wash., KXRO, Inc., 75 w.

KYW

1020 kc, Chicago, Ill., Westinghouse E. & M. Co., 5000 w, C.

KYWA

1020 kc, Chicago, Ill., Westinghouse Elec. & Mfg. Co., 500 w, C.

KZM

1370 kc, Hayward, Calif., Leon P. Tenney, 100 w, P.

NAA

690 kc, 434.5 m, United States Navy Department, Washington, D. C., 1000 w, "Where the Time Signals Originate," E.

WAAF

920 kc, Chicago, Ill., Drovers Journal Pub. Co., 500 w daytime, C.

WAAM

1250 kc, Newark, N. J., WAAM, Inc., 1000 w, E, "Sunshine Station."

WAAT

1070 kc, Jersey City, N. J., Bremer Broadcasting Corp., 300 w, E.

WAAW

660 kc, Omaha, Neb., Omaha Grain Exchange, 500 w daytime, C, "Pioneer Market Station of the West."

WABC

860 kc, New York City, N. Y., Atlantic Broadcasting Corp., 5000 w, E.

WABI

1200 kc, Bangor, Maine, First Universalist Church, 100 w, E, "The Pine Tree Wave."

WABO

See under WHEC.

WABZ

1200 kc, New Orleans, La., Coliseum Place Baptist Church, 100 w, C.

WADC

1320 kc, Tallmadge, Ohio, Allen T. Simmons, 1000 w, E, "Watch Akron Develop Commercially."

WAGM

1310 kc, Royal Oak, Mich., Robert L. Miller, 50 w, E.

WAIU

640 kc, Columbus, Ohio, American Insurance Union, 500 w, E, "The Radio Voice of the American Insurance Union."

WAPI

1140 kc, Birmingham, Ala., Alabama Polytechnic Institute, 5000 w, C.

WASH

1270 kc, Grand Rapids, Mich., WASH Broadcasting Corp., 500 w, C.

WBAA

1400 kc, Lafayette, Ind., Purdue University, 500 w, C.

WBAK

1430 kc, Harrisburg, Pa., Pennsylvania State Police, 500 w, E, "The Voice of Pennsylvania."

WBAL

1060 kc, Baltimore, Md., Consolidated Gas, Elec. Co., 10,000 w, E, "The Station of Good Music."

WBAP

800 kc, Ft. Worth, Tex., Carter Publications, Inc., 50,000 w, C.

WBAW

1490 kc, Nashville, Tenn., Tennessee Publishing Co., 5000 w, C.

WBAX

1210 kc, Wilkes-Barre, Pa., John H. Stenger, Jr., 100 w, E, "In Wyoming Valley, Home of the Anthracite."

WBBC

1400 kc, Brooklyn, N. Y., Brooklyn Broadcasting Corp., 500 w.

WBBL

1370 kc, Richmond, Va., Grace Covenant Presbyterian Church, 100 w, E, "Richmond, the Gateway North and South."

WBBM

770 kc, Chicago, Ill., Atlas Investment Co., 25,000 w, C.

WBBR

1300 kc, Rossville, N. Y., People's Pulpit Association, 1000 w, E, "Watch Tower."

WBBY

1200 kc, Charleston, S. C., Washington Light Infantry, 75 w, E, "The Seaport of the Southeast."

WBBZ

1200 kc, Ponca City, Okla., C. L. Carrell, 100 w, C.

WBCM

1410 kc, Bay City, Mich., James E. Davidson, 500 w, E, "Where the Summer Trail Begins."

WBCN

See under WENR.

WBIS

See under WNAC.

WBMS

1450 kc, Fort Lee, N. J., WBMS Broadcasting Corp., 250 w.

WBNY

1350 kc, New York, N. Y., Baruchrome Corp., 250 w, E, "The Voice of the Heart of New York."

WBOQ

See under WABC.

WBOW

1310 kc, Terre Haute, Ind., Banks of Wabash Broadcasting Assn., 100 w, C, "On the Banks of the Wabash."

WBRC

930 kc, Birmingham, Ala., Birmingham Broadcasting Co., 500 w, C, "The Biggest Little Station in the World."

WBRE

1310 kc, Wilkes-Barre, Pa., Louis G. Baltimore, 100 w, E.

WBRL

1430 kc, Tilton, N. H., Booth Radio Laboratories, 500 w, E.

WBSO

920 kc, Wellesley Hills, Mass., Babson's Statistical Org., Inc., 250 w, E.

WBT

1080 kc, Charlotte, N. C., Station WBT, Inc., 5000 w, E, shared, "The Queen City of the South."

WBZ

990 kc, Springfield, Mass., Westinghouse E. & M. Co., 15,000 w, E, "The Broadcasting Station of New England."

WBZA

990 kc, Boston, Mass., Westinghouse E. & M. Co., 500 w, E.

WCAC

600 kc, Storrs, Conn., Connecticut Agricultural College, 250 w, E, "Voice from the Nutmeg State."

WCAD

1220 kc, Canton, N. Y., St. Lawrence University, 500 w, E, "The Voice of the North Country."

WCAE

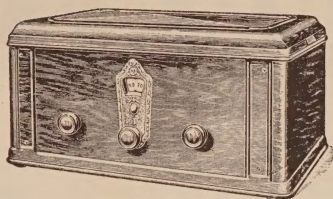
1220 kc, Pittsburgh, Pa., Kaufman & Baer Co., 500 w, E, "Where Prosperity Begins."

WCAH

1430 kc, Columbus, Ohio, Commercial Radio Service Co., 500 w, E.

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COVERS 200—600 METERS



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WCAL

1250 kc, Northfield, Minn., St. Olaf College, 1000 w, C, "The College on the Hill."

WCAM

1280 kc, Camden, N. J., City of Camden, 500 w, E.

WCAO

600 kc, Baltimore, Md., Monumental Radio, Inc., 250 w, E, "The Gateway of the South."

WCAP

1280 kc, Asbury Park, N. J., Radio Industries Broadcast Co., 500 w, E.

WCAT

1200 kc, Rapid City, S. D., South Dakota State School of Mines, 100 w, M.

WCAU

1170 kc, Philadelphia, Pa., Universal Broadcasting Co., 10,000 w, E, "Where Cheer Awaits U."

WCAX

1200 kc, Burlington, Vt., University of Vermont, 100 w, E.

WCAZ

1070 kc, Carthage, Ill., Carthage College, 50 w.

WCBA

1440 kc, Allentown, Pa., B. B. Musselman, 250 w, E.

WCB D

1080 kc, Zion, Ill., Wilbur Glen Voliva, 5000 w, C.

WCBM

1370 kc, Baltimore, Md., Baltimore Broadcasting Corp., 100 w, E.

WCB S

1210 kc, Springfield, Ill., Dewing & Meester, 100 w, C.

WCCO

810 kc, Minneapolis, Minn., Northwestern Bdcstg., Inc., 7500 w, C, "Service to the Northwest."

WCDA

1350 kc, New York, N. Y., Italian Educational Broadcasting Co., 250 w, E.

WCFL

1280 kc, Chicago, Ill., Chicago Federation of Labor, 1000 w, C, "The Voice of Labor."

WCGU

1400 kc, Coney Island, N. Y., U. S. Broadcasting Corp, 500 w, E.

WCKY

1480 kc, Covington, Ky., L. B. Wilson, 5000 w, E.

WCLO

1200 kc, Kenosha, Wis., C. Whitmore, 100 w, C.

WCLS

1310 kc, Joliet, Ill., WCLS, Inc., 100 w, C.

WCMA

1400 kc, Culver, Ind., Culver Military Academy, 500 w, C, "The Voice of Culver."

WCOA

1340 kc, Pensacola, Fla., City of Pensacola, 500 w, E, "Wonderful City of Advantages."

WCOC

880 kc, Meridian, Miss., Crystal Oil Co., 500 w, C.

WCOD

1200 kc, Harrisburg, Pa., N. R. Hoffman Co., 100 w, E.

WCOH

1210 kc, Yonkers, N. Y., Westchester Broadcasting Corp., 100 w, E.

WCRW

1210 kc, Chicago, Ill., Clinton R. White, 100 w, C.

WCSH

940 kc, Portland, Me., Congress Square Hotel Co., 500 w, E, "The Voice From Sunrise Land."

WCSO

1450 kc, Springfield, Ohio, Wittenberg College, 500 w, E.

WDAE

1240 kc, Tampa, Fla., Tampa Publishing Co., 1000 w, E, "WDAE, the Voice of the Times at Tampa."

WDAF

610 kc, Kansas City, Mo., Kansas City Star Co., 1000 w, C, "Enemies of Sleep."

WDAG

1410 kc, Amarillo, Texas, National Radio & Broadcasting Corp., 250 w, C, "Where Dollars Always Grow."

WDAH

1310 kc, El Paso, Texas, Trinity Methodist Church, 100 w, M.

WDAY

940 kc, Fargo, N. D., WDAY, Inc., 1000 w, C.

WDBJ

930 kc, Roanoke, Va., Richardson-Wayland Elec. Corp., 250 w, E, "The Magic City."

WDBO

1120 kc, Orlando, Fla., Rollins College, Inc., 1000 w, E, "Down Where the Oranges Grow."

WDEL

1120 kc, Wilmington, Del., WDEL, Inc., 250 w, E, "First City of the First State."

WDGY

1180 kc, Minneapolis, Minn., Dr. Geo. W. Young, 1000 w, C.

WDOD

1280 kc, Chattanooga, Tenn., Chattanooga Radio Co., Inc., 1000 w, C.

WDRC

1330 kc, New Haven, Conn., Doolittle Radio Corp., 500 w, E.

WDSU

1250 kc, New Orleans, La., Jos. H. Uhalt, 1000 w, C.

WDWF

1210 kc, Providence, R. I., Duttee W. Flint and The Lincoln Studios, 100 w, E.

WDZ

1070 kc, Tuscola, Ill., James L. Bush, 100 w.

WEAF

660 kc, New York, N. Y., National Broadcasting Co., Inc., 50,000, w, E.

WEAI

1270 kc, Ithaca, N. Y., Cornell Univ., 500 w, E.

WEAN

780 kc, Providence, R. I., The Shepard Stores Co., 250 w, E, "We Entertain a Nation."

WEAO

550 kc, Columbus, Ohio, Ohio State University, 750 w, E.

WEAR

1070 kc, Cleveland, Ohio, WTAM and WEAR, Inc., 1000 w, E.

WEBC

1290 kc, Superior, Wis., Head of The Lakes Broadcasting Co., 1000 w, C.

WEBE

1210 kc, Cambridge, Ohio, Roy W. Waller, 100 w, E.

WEBQ

1210 kc, Harrisburg, Ill., First Trust & Savings Bank, 100 w, C.

WEBR

1310 kc, Buffalo, N. Y., Howe'l Broadcasting Co., 100 w, E, "We Extend Buffalo's Regards."

WEBW

560 kc, Beloit, Wis., Beloit College, 500 w, C.

WEDC

1210 kc, Chicago, Ill., Emil Denmark, Inc., 100 w.

WEDH

1420 kc, Erie, Pa., Erie Dispatch-Herald, 30 w, E.

WEEI

590 kc, Boston, Mass., Edison Elec. Illum. Co., 1000 w, E, "The Friendly Voice."

WEHC

1370 kc, Emory, Va., Emory and Henry College, 100 w, E.

WEHS

1420 kc, Evanston, Ill., Victor C. Carlson, 100 w, C.

LET RCA INSTITUTES START YOU ON THE ROAD TO . . . SUCCESS IN RADIO

Radio needs you . . . That's why the entire Radio industry is calling for trained men . . . That's why thousands of men who answered these advertisements are now earning from \$2,000 and up a year. Radio is thrilling work . . . easy hours, too, vacations with pay and a chance to see the world. Manufacturers and broadcasting stations are now eagerly seeking trained RCA men . . . Aviation and radio in the movies also provide innumerable opportunities . . . Millions of sets need servicing . . . thousands of ships require experienced operators . . . Never before was there an opportunity like this.



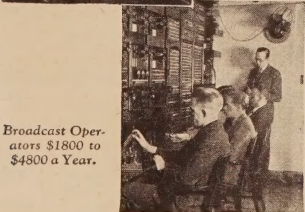
Radio Mechanic and Inspector
\$1800 to \$4000 a Year.



Broadcast Station Mechanic
\$1800 to \$3600 a Year.



Land Station Operator
\$1800 to \$4000 a Year.



Broadcast Operators
\$1800 to \$4800 a Year.

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RCA sets the standards for the entire Radio industry . . . The RCA Institutes' Home Laboratory Training Course enables you to quickly learn all the secrets of Radio . . . In your spare time, in only an hour or so a day, you can obtain a thorough, practical education in Radio . . . You get the inside information, too, because you study right at the source of all the latest, up-to-the-minute developments. RCA, the world's largest Radio organization sponsors every single detail in this course.

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Name.....

Address.....

WELK

1370 kc, Philadelphia, Pa., Howard R. Miller, 100, E.

WEMC

590 kc, Berrien Springs, Mich., Emmanuel Missionary College, 1000 w, C, "The Radio Light-house."

WENR

870 kc, Chicago, Ill., Great Lakes Radio Broadcasting Co., 50,000 w, C, "Voice of Service."

WEVD

1300 kc, New York, N. Y., Debs Memorial Radio Fund, 500 w, E.

WEW

760 kc, St. Louis, Mo., St. Louis University, 1000 w, C.

WFAA

800 kc, Dallas, Texas, Dallas News and Journal, 10,000 w, C, "Working for All Alike."

WFAN

610 kc, Philadelphia, Pa., Keystone Broadcasting Co., Inc., 500 w, E.

WFBC

1200 kc, Knoxville, Tenn., First Baptist Church, 50 w, E.

WFBG

1310 kc, Altoona, Pa., William F. Gable Co., 100 w, E, "The Original Gateway to the West and We Wish You All the Very Best."

WFBJ

1370 kc, Collegeville, Minn., St. Johns University, 100 w, C, "In the Heart of the Landscape Paradise."

WFBL

900 kc, Syracuse, N. Y., The Onondaga Co., Inc., 750 w, E, "When Feeling Blue, Listen."

WFBM

1230 kc, Indianapolis, Ind., Indianapolis Power & Light Co., 1000 w, C.

WFBR

1270 kc, Baltimore, Md., Baltimore Radio Show, Inc., 250 w, E, "Home of the Star Spangled Banner."

WFDF

1310 kc, Flint, Mich., Frank D. Fallain, 100 w, E.

WFI

560 kc, Philadelphia, Pa., Strawbridge & Clothier, 500 w, E, "Key City of Industry."

WFIW

940 kc, Hopkinsville, Ky., The Acme Mills, Inc., 1000 w, C.

WFJC

1450 kc, Akron, Ohio, W. F. Jones Broadcasting, Inc., 500 w, E.

WFKD

1310 kc, Philadelphia, Pa., Foulkrod Radio Eng. Co., 50 w, E.

WFLA

620 kc, Clearwater, Fla., Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce, 1000 w, E, "Inviting the World to the Springtime City."

WGAL

1310 kc, Lancaster, Pa., Lancaster Elec. Sup. & Const. Co., 15 w, E, "World's Gardens at Lancaster."

WGBB

1210 kc, Freeport, N. Y., Harry H. Carman, 100 w, E, "The Voice of the Sunrise Trail."

WGBC

1430 kc, Memphis, Tenn., First Baptist Church, 500 w, C, Shared.

WGBF

630 kc, Evansville, Ind., Evansville on Air, 500 w, E, "Gateway to the South."

WGBI

880 kc, Scranton, Pa., Scranton Broadcasters, Inc., 250 w, E.

WGBS

1180 kc, New York, N. Y., General Broadcasting System, Inc., 500 w, E.

WGCM

1210 kc, Gulfport, Miss., Great Southern Land Co., Inc., 100 w, C.

WGCP

1250 kc, Newark, N. J., May Radio Broadcast Corp., 250 w.

WGES

1360 kc, Chicago, Ill., Oak Leaves Broadcasting Corp., 500 w, C, "World's Greatest Entertainment Service."

WGH

1310 kc, Newport News, Va., Virginia Broadcasting Co., Inc., 100 w, E.

WGHP

1240 kc, Detroit, Mich., American Broadcasting Corp., Inc., 750 w, E.

WGL

1370 kc, Ft. Wayne, Ind., Allen-Wayne Co., 100 w, C.

WGMS

See under WLB.

WGN

720 kc, Chicago, Ill., Tribune Co., 25,000 w, C.

WGR

550 kc, Buffalo, N. Y., WGR, Inc., 1000 w, E.

WGST

890 kc, Atlanta, Ga., Georgia School of Technology, 500 w, E, "The Southern School with the National Reputation."

WGY

790 kc, Schenectady, N. Y., General Electric Co., 50,000 w, E.

WHA

940 kc, Madison, Wis., University of Wisconsin, 750 w, C.

WHAD

1120 kc, Milwaukee, Wis., Marquette University, 250 w, C.

WHAM

1150 kc, Rochester, N. Y., Stromberg-Carlson Tel. Mfg. Co., 5000 w, E.

WHAP

1300 kc, New York, N. Y., Defenders of Truth Society, Inc., 1000 w, E.

WHAS

820 kc, Louisville, Ky., The Courier Journal Co. & Louisville Times Co., 10,000 w, C.

WHAT

1310 kc, Philadelphia, Pa., A. A. Walker, 100 w, E.

WHAZ

1300 kc, Troy, N. Y., Rensselaer Polytechnic Institute, 500 w, E.

WHB

710 kc, Kansas City, Mo., Sweeney Auto School, 500 w, C.

WHBC

1200 kc, Canton, Ohio, St. John's Catholic Church, 10 w, E.

WHBD

1370 kc, Mt. Orab, Ohio, F. P. Moler, 100 w, E, "Ohio's Highest Point."

WHBF

1210 kc, Rock Island, Ill., Beardsley Specialty Co., 100 w, C.

WHBL

1410 kc, Sheboygan, Wis., Press Pub. Co., 500 w, C.

WHBQ

1370 kc, Memphis, Tenn., Broadcasting Station WHBQ, Inc., 100 w, C.

WHBU

1210 kc, Anderson, Ind., Citizens Bank, 100 w, C, "First Hoosier Bank on the Air."

WHBY

1200 kc, Green Bay, Wis., St. Norbert's College, 100 w, C.

WHDF

1370 kc, Calumet, Mich., Upper Michigan Brdcastg. Co., 100 w, C.

WHDL

1420 kc, Tupper Lake, N. Y., G. F. Bissell, 10 w, E.

WHDH

830 kc, Gloucester, Mass., Matheson Radio Co., Inc., 1000 w, E.

WHDI

1180 kc, Minneapolis, Minn., Wm. Hood Dunwoody Ind. Inst., 500 w, C.

WHEC

1440 kc, Rochester, N. Y., Hickson Electric Co., Inc., 500 w, E.

WHFC

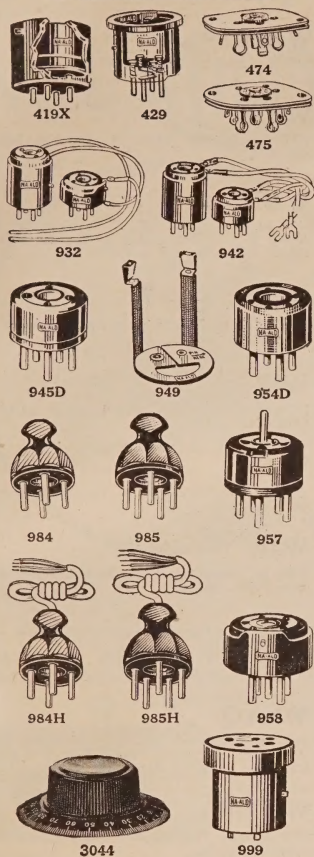
1420 kc, Cicero, Ill., Triangle Broadcasters, 100 w, C.

WHIS

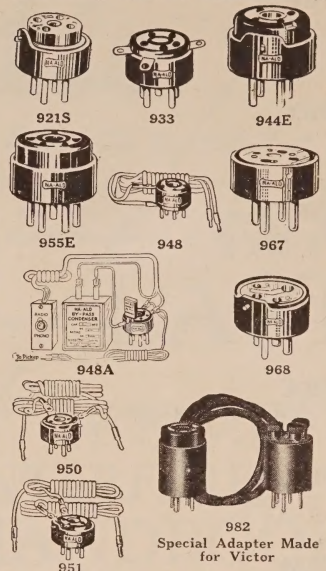
1420 kc, Bluefield, W. Va., Daily Telegraph Printing Co., 100 w, E.



Group I
For the MANUFACTURER



Group II
For the RADIOTRICIAN and the
SERVICE DEPARTMENT
(See Group I for the Manufacturer)



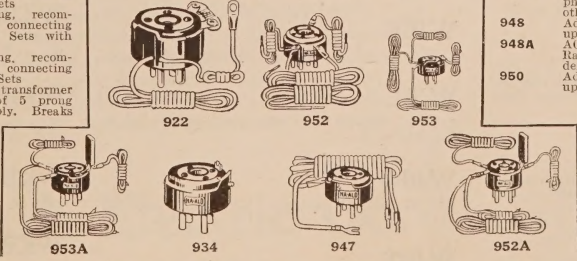
Group I. For the MANUFACTURER
Something Better at a Lower Price

- 419X Adapter—For adapting UX199 Tubes to UV201A Sockets
- 429 Adapter—For adapting UV199 Tubes to UV201A and UX Sockets
- 464 Sockets—Sport Model—4 prong—molded sub panel 1-9/16" mounting holes.
- 465 Socket—5 prong Sport Model—molded sub panel 1-9/16" mounting holes.
- 474 Socket—4 prong Laminated—any marking—any hole arrangement
- 475 Socket—5 prong Laminated—any marking—any hole arrangement
- 701M Socket—Suregrip Wall Plug for receivers, speakers, service instruments—all electrical appliances
- 914 Socket—Speaker Connector Plug—4 prong—priced lower than 984
- 915 Socket—Speaker Connector Plug—4 prong—priced lower than 984
- 927H Adapter—5 hole 4 prong—leads to nearer holes—fil. prongs shorted
- 927N Adapter—5 hole 4 prong—leads to nearer holes—fil. prongs shorted
- 932 Adapter—Two Adapters for testing UX222 Shielded Grid Tubes in Jewell Testers
- 942 Twin Adapters for testing 5 prong A. C. Tubes in Jewell Testers
- 944GT Adapter—4 hole 4 prong Adapter, breaks grid circuit, phone tip terminals—other connections through
- 955GT Adapter—5 hold 5 prong Adapter, breaks grid circuit, phone tip terminals—other connections through
- 944YN Adapter—For Analyzers—4 hole 4 prong—all connections through lead clips out from P-G-F minus
- 955YN Adapter—For Analyzers—4 hole 4 prong—all connections through lead clips from P-G-K
- 945 Adapter—For adapting 4 prong UX Tubes to 5 prong UY Sockets
- 945D Adapter—For adapting 4 prong UX Tubes to 5 prong UY Sockets (smaller diameter 1-7/32")
- 945H Adapter—Like 945 with K connected to adjacent H
- 945JM Adapter—4 hole 5 prong—1 3/4" tall—P hole to 12 prong—G hole to P prong—K prong dead—F F to H H
- 949 Adapter—Universal for connecting Electric Pickup fitting either four or five prong tubes into grid circuit, employed by manufacturers to replace inbuilt phone jack
- 949P Adapter—(As illustration of 949 reversed) For connecting Electric Pickup to plate circuit of A, C, or D. C. sets. Plane Tip Terminals on P and P
- 949G Adapter—Like 949, but no lead clip to Fil.
- 954 Adapter—For adapting 5 prong UY Tubes to 4 prong UX Sockets
- 954D Adapter—For adapting 5 prong UY Tubes to 4 prong UX Sockets, small diameter, no side pin
- 954A Adapter—Like 954, but K hole not connected to adjacent H
- 955GKA Adapter—Like 955GT with lead clip from K
- 955KTS Adapter—5 hole 5 prong with insulated phone tip terminals breaking be used as pickup adapter or with volume control as phone-radio switch
- 957 Adapter—Weston 4 hole, 5 prong Adapter with top center stud
- 958 Adapter—Weston 5 hole 4 prong Adapter with extra center prong
- 984 Speaker Connector Plug—4 prong for standard socket, all molded. Used by manufacturers of sets, speakers, and service instruments. Also ideal for service man's present equipment
- 985 Speaker Connector Plug—5 prong for standard socket, all molded. Used by manufacturers of sets, speakers and service instruments. Also ideal for service man's present equipment

Group III
For IMPROVING Your Set

- 922 Adapter—For adapting any socket for UX222 Shielded Grid Tube
- 955PT Adapter—For listening in on Detector of A. C. sets with head phones, breaks plate circuit, 2 phone tip terminals
- 934 For Oscillation control in R F stages (Takes Grid Suppressors of values 200, 300, 500, 700, 1000 ohms)
- R200 to R1000 Grid Suppressors—For 934
- 947 Adapter—Recommended for Victor for connecting Radiolas to Electrola Power Amplifier
- 952A Adapter—5 hole, 5 prong, recommended by Samson for connecting PAM Amplifiers to A. C. Sets, has R. F. Bypass Condenser
- 952 Adapter—5 hole, 5 prong, recommended by Samson for connecting PAM Amplifiers to A. C. Sets
- 953A Adapter—4 hole, 4 prong, recommended by Samson for connecting PAM Amplifiers to D. C. Sets with R. F. Bypass Condenser
- 953 Adapter—4 hole, 4 prong, recommended by Samson for connecting PAM Amplifiers to D. C. Sets
- 959 Adapter—To connect input transformer of power amplifier to P of 5 prong tube and direct to B Supply. Breaks plate, lead to P hole and extra lead to connect to plus B
- 304 NA-ALD TRIPHONIC Amplifiers for improvement of any D. C. set
- 300-301 301R Respectively last state, intermediate and first stage TRIPHONIC Couplers
- 421X Adapter—For adapting UX Tubes to WD11 Sockets

Group III
For IMPROVING Your Set



Group II
For the RADIOTRICIAN and the
SERVICE DEPARTMENT
(See Group I for the Manufacturer)

- 921S Adapter—For cushioning microphonic tubes in either UX or UV201A Sockets
- 933 Adapter—5 hole 3 prong. Breaks plate circuit, other connections through, 3 clips brought out, plate hole, plate prong, cathode
- 944E Adapter—4 hole, 4 prong adapter 3/4" inch high with all connections through high with all connections through
- 955E Adapter—3 hole, 5 prong adapter 3/4" high with all connections through
- 944 Adapter—(Not illustrated) as 944E except 3/4" high
- 955 Adapter—(Not illustrated) as 955E except 3/4" high
- 944GP Test Adapter—4 hole 4 prong, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones
- 955GP Test Adapter—5 hole, 5 prong, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones
- 944N Neutralizing Adapter—4 hole, 4 prong, one fil. lead, all other connections through
- 955N Neutralizing Adapter—5 hole, 5 prong, one fil. lead, all other connections through
- 944PTT Universal Testing Adapter—4 hole, 4 prong plate break—other connections through—5 phone tip terminals, from P prong, P hole F. F. G.
- 955PTT Universal Testing Adapter—5 hole, 5 prong plate break—other connections through—6 terminals, cathode included
- 955PT Test Adapter—5 hole, 5 prong—2 phone tip terminals, plate break—other connections through, no leads
- 948 Adapter—For connecting Electric Pickup in plate circuit of 5 prong tubes
- 948A AC Pickup Adapter—Complete with Radio-Phono Switch and Bypass Condensers
- 950 Adapter—For connecting Electric Pickup in grid circuit of 4 Prong Tubes
- 951 Adapter—For connecting Electric Pickup in plate circuit of 4 prong tubes
- 955KTS Pickup Adapter, breaks Cathode Circuit, 2 phone tip terminals
- 967 Adapter—For adapting UV201A Tubes to UX Sockets
- 968 Adapter—For adapting WD11 Tubes to UX Sockets
- 982 Adapter—Special for Victor

Dept. J

ALDEN MANUFACTURING CO.

Brockton, Mass.

WHK

1390 kc, Cleveland, Ohio, Radio Air Service Corp.,
1000 w, E, "Cleveland's Pioneer Station."

WHN

1010 kc, New York, N. Y., Marcus Loew Booking
Review, 250 w, E, "Voice of the Great White
Way."

WHO

1000 kc, Des Moines, Iowa, Bankers Life Co.,
5000 w, C, "W-H-O, Who? Banker's Life, Des
Moines."

WHP

1430 kc, Harrisburg, Pa., Pennsylvania Broadcast-
ing Co., 500 w, E.

WIAS

1420 kc, Ottumwa, Iowa, Poling Electric Co., 100
w, C.

WIBA

1210 kc, Madison, Wis., Capital Times Co., 100
w, C.

WIBG

930 kc, Elkins Park, Pa., St. Paul's M. E.
Church, 50 w, E.

WIBM

1370 kc, Jackson, Mich., C. L. Carrell, 100 w.

WIBO

560 kc, Chicago, Ill., Nelson Bros. Bond & Mort-
gage Co., 1000 w, C.

WIBR

1420 kc, Steubenville, Ohio, G. W. Robinson,
50 w, E, "Where Investments Bring Results."

WIBS

1450 kc, Elizabeth, N. J., New Jersey Broadcasting
Co., 250 w, E.

WIBU

1310 kc, Poynette, Wis., W. C. Forrest, 100 w, C.

WIBW

580 kc, Topeka, Kan., Topeka Broadcasting Assn.,
Inc., 1000 w, C, "Topeka—Where Investment
Brings Wealth."

WIBX

1200 kc, Utica, N. Y., WIBX, Inc., 100 w, E.

WICC

1190 kc, Bridgeport, Conn., Bridgeport Broadcast-
ing Station, Inc., 500 w, E, "The Industrial Cap-
ital of Connecticut."

WIL

1200 kc, St. Louis, Mo., Missouri Broadcasting
Co., 100 w, C, "A Wave Length Ahead."

WILL

890 kc, Urbana, Ill., University of Illinois, 250
w, C.

WILM

1420 kc, Wilmington, Del., Delaware Broadcasting
Co., Inc., 100 w, E.

WIOD

1300 kc, Miami Beach, Fla., Isle of Dreams Broad-
casting Co., 1000 w, E, "Wonderful Isle of
Dreams."

WIP

610 kc, Philadelphia, Pa., Gimbel Bros., Inc., 500
w, E, "Watch Its Progress."

WISN

1120 kc, Milwaukee, Wis., Evening Wisconsin Co.,
250 w, C.

WJAC

1310 kc, Johnstown, Pa., Johnstown Automobile
Co., 100 w, E, "The Voice of the Friendly City."

WJAD

1240 kc, Waco, Texas, Frank P. Jackson, 1000 w,
C, shared, "Waco, Texas, All Around It."

WJAG

1060 kc, Norfolk, Neb., Norfolk Daily News, 1000
w, C, "Home of the Printer's Devil."

WJAK

1310 kc, Marion, Ind., Marion Brdcast. Co., 50 w.

WJAR

890 kc, Providence, R. I., The Outlet Co., 250 w,
E, "The Southern Gateway of New England."

WJAS

1290 kc, Pittsburgh, Pa., Pittsburgh Radio Supply
House, 1000 w, E.

WJAX

900 kc, Jacksonville, Fla., City of Jacksonville.
1000 w, E, "WJAX—W for Wonderful, JAX for
Jacksonville."

WJAY

620 kc, Cleveland, Ohio, Cleveland Radio Broad-
casting Corp., 500 w, E.

WJAZ

1480 kc, Chicago, Ill., Zenith Radio Corp., 5000
w, C.

WJBC

1200 kc, LaSalle, Ill., Hummer Furniture Co., 100
w, C.

WJBI

1210 kc, Red Bank, N. J., Robt. S. Johnson, 100
w, E.

WJBK

1370 kc, Ypsilanti, Mich., J. F. Hopkins, 50 w, C.

WJBL

1200 kc, Decatur, Ill., Wm. Gushard Dry Goods
Co., 100 w, C.

WJBO

1370 kc, New Orleans, La., Valdemar Jensen, 100
w, C.

WJBT

See under WBBM.

WJBU

1210 kc, Lewisburg, Pa., Bucknell University, 100
w, E, "In the Heart of the Keystone State."

WJBW

1200 kc, New Orleans, La., C. Carlsen, Jr., 30 w,
C, "The Serve You Broadcasting Station at New
Orleans."

WJBY

1210 kc, Gadsden, Ala., C. J. Black, 50 w, C.

WJDX

1270 kc, Jackson, Miss., Lamar Life Ins. Co.,
500 w, C.

WJJD

1130 kc, Moosheart, Ill., Loyal Order of Moose,
20,000 w, C, "Every Child Is Entitled to a High
School Education and a Trade."

WJKS

1360 kc, Gary, Ind., Johnson-Kennedy Radio Corp.,
500 w, C.

WJR

750 kc, Detroit, Mich., The Goodwill Station, Inc.
5000 w, E.

WJSV

1460 kc, Mt. Vernon Hills, Va., Independent Pub.
Co., 10,000 w.

WJW

1210 kc, Mansfield, Ohio, Mansfield Broadcasting
Association, 100 w, E.

WJZ

760 kc, New York City, N. Y., Radio Corporation
of America, 30,000 w, E.

WKAQ

890 kc, San Juan, Porto Rico, Radio Corp. of
Porto Rico, 500 w, E, "Porto Rico, The Island of
Enchantment in the Caribbean Sea."

WKAR

1040 kc, East Lansing, Mich., Michigan State Col-
lege, 1000 w, E.

WKAV

1310 kc, Laconia, N. H., Laconia Radio Club, 100
w, E, "The Voice of the Winnepesaukee Lake
Region."

WKBB

1310 kc, Joliet, Ill., Sanders Bros., 100 k, C.

WKBC

1310 kc, Birmingham, Ala., R. B. Broyles Furni-
ture Co., 100 w, C.

WKBF

1400 kc, Indianapolis, Ind., Noble Butler Watson,
500 w, C, "We Keep Building Friendships."

WKBH

1380 kc, LaCrosse, Wis., Callaway Music Co.,
1000 w, C.

WKBI

1420 kc, Chicago, Ill., Fred L. Schoenwolf, 50 w, C.

WKBN

570 kc, Youngstown, Ohio, W. P. Williamson,
Jr., 500 w, E.

WKBO

1450 kc, Jersey City, N. J., Camith Corp., 250
w, E.

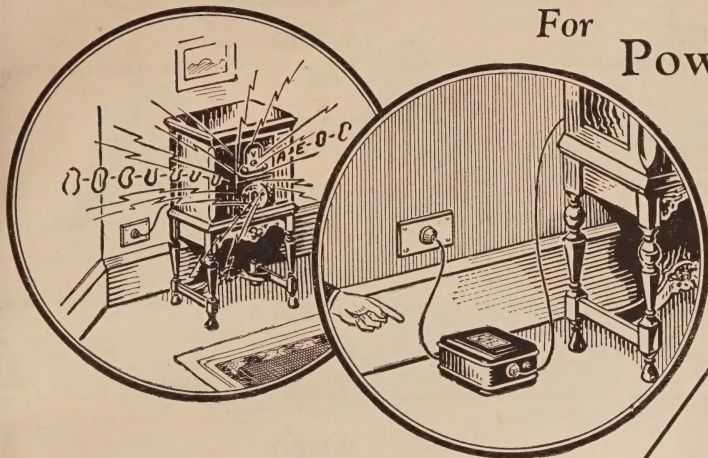
Breaking All Sales Records!

New **TOBE** Filterette

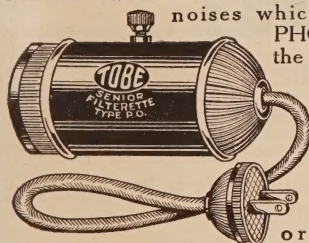
For
Power-Line
Noises

AT LAST

A SIMPLE INTERFERENCE HANDBOOK



Are the electrical disturbances in your neighborhood being carried by "DIRECT WIRE" right to your set? Tobe Filterettes Senior and 110 P. O. instantly cut down the noises which are being TELE-



PHONED to your set over the electric light wiring in your home. Put one on your set. Notice the difference! The little senior* will eliminate most ordinary interference, and for stubborn cases there is the 110 P. O.† more than twice as powerful. Or stop the trouble at the source with one of the 64 TOBE Filterette Models. Backed by a name that for years has stood for the ultimate in SERVICE.

*Tobe Filterette Senior
Price \$7.50

†Tobe Filterette 110 P. O.
Price \$12.50

PHONED to your set over the electric light wiring in your home. Put one on your set. Notice the difference! The little senior* will eliminate most ordinary

The Newark Electric Company takes pleasure in offering to its friends the latest and most authoritative work on Radio Interference, The Tobe Filterette Manual.

A complete instruction book for all—written so anybody can understand it. Profusely illustrated. Plenty of photographs, diagrams, etc., showing just how interference is stopped.

Put out by the acknowledged authority in

this field,

the Tobe Deutschmann Corporation. To

this company is due largely the credit for the nation-wide publicity given the problem. For years past they

have been waging the fight against interference—creating electrical apparatus. Now they offer you the benefit of those years of research in a sixty-four page book, covering every phase of the problem.

Copies of this book may be obtained by writing to the Newark Electric Company, 226 West Madison Street, Chicago, Illinois. The price of the book is twenty-five cents. Postpaid.

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Chicago, Illinois

Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

WKBP

1420 kc, Battle Creek, Mich., Enquirer-News Co., 50 w, E.

WKBQ

1350 kc, New York, N. Y., Standard Cahill Co., Inc., 250 w, E.

WKBS

1310 kc, Galesburg, Ill., Permil N. Nelson, 100 w, C.

WKBV

1500 kc, Brookville, Ind., Knox Battery & Electric Co., 100 w, C.

WKBW

1470 kc, Buffalo, N. Y., Churchill Evan. Assn., Inc., 5000 w, E.

WKBZ

1500 kc, Ludington, Mich., K. L. Ashbacker, 50 w.

WKEN

1040 kc, Buffalo, N. Y., WKEN, Inc., 1000 w, E.

WKJC

1200 kc, Lancaster, Pa., Kirk Johnson & Co., 100 w, E.

WKRC

550 kc, Cincinnati, Ohio, J. S. Boyd, 500 w, E, "WKRC, K—Kodel, R—Radio, C—Corporation."

WKY

900 kc, Oklahoma City, Okla., WKY Radiophone Co., 1000 w, C.

WLAC

1490 kc, Nashville, Tenn., Life & Casualty Ins. Co., 5000 w, C, "The Thrift Station."

WLAP

1200 kc, Louisville, Ky., American Broadcasting Corp. of Kentucky, 30 w, C.

WLB

1250 kc, Minneapolis, Minn., University of Minnesota, 500 w, C.

WLBC

1310 kc, Muncie, Ind., Donald A. Burton, 50 w.

WLBF

1420 kc, Kansas City, Kan., Everett L. Dillard, 100 w, C, "Where Listeners Become Friends."

WLBG

1200 kc, Petersburg, Va., Robert Allen Gamble, 100 w, E.

WLBL

900 kc, Stevens Point, Wis., Wisconsin Department of Markets, 2000 w, daytime, C, "Wisconsin, Land of Beautiful Lakes."

WLBW

1260 kc, Oil City, Pa., Radio-Wired Program Corp., 500 w, E.

WLBX

1500 kc, Long Island City, N. Y., John N. Brahy, 100 w.

WLBZ

620 kc, Bangor, Me., Maine Broadcasting Co., 500 w, E.

WLCI

1210 kc, Ithaca, N. Y., Lutheran Assn. of Ithaca, 50 w, E.

WLEX

1360 kc, Lexington, Mass., Lexington Air Station, 500 w, E.

WLEY

1420 kc, Lexington, Mass., Lexington Air Station, 100 w, E.

WLIB

See under WGN.

WLIT

560 kc, Philadelphia, Pa., Lit Brothers, 500 w, E, "The Quaker City Siren."

WLOE

1500 kc, Boston, Mass., Boston Broadcasting Co., 100 w.

WLS

870 kc, Chicago, Ill., Agricultural Broadcasting Co., 5000 w, C.

WLSI

See under WDWF.

WLTH

1400 kc, Brooklyn, N. Y., Voice of Brooklyn, Inc., 500 w, E.

WLW

700 kc, Cincinnati, Ohio, Crosley Radio Corp., 50,000 w, E.

WLWL

1100 kc, New York, N. Y., Missionary Society of St. Paul, 5000 w, E.

WMAC

570 kc, Casenovia, N. Y., Clive B. Meredith, 250 w, E, "Voice of Central New York."

WMAF

1360 kc, So. Dartmouth, Mass., Round Hills Radio Corp., 500 w, E.

WMAK

900 kc, Buffalo, N. Y., WMAK Broadcasting System, Inc., 750 w, E.

WMAL

630 kc, Washington, D. C., M. A. Leese Co., 250 w, E.

WMAN

1210 kc, Columbus, Ohio, W. E. Heskitt, 50 w, E.

WMAQ

670 kc, Chicago, Ill., Chicago Daily News, Inc., 5000 w, C.

WMAY

1200 kc, St. Louis, Mo., Kingshighway Presbyterian Church, 100 w, C.

WMAZ

890 kc, Macon, Ga., Macon Junior Chamber of Commerce, 250 w, E, shared, "Watch Mercer Attain Zenith."

WMBA

1500 kc, Newport, R. I., LeRoy Joseph Beebe, 100 w, E.

WMBC

1420 kc, Detroit, Mich., Michigan Broadcasting Co., Inc., 100 w, E.

WMBD

1440 kc, Peoria Heights, Ill., Peoria Heights Radio Laboratory, 500 w.

WMBF

See under WIOD.

WMBG

1210 kc, Richmond, Va., Havens & Martin, Inc., 100 w, E, "The Daytime Station."

WMBH

1420 kc, Joplin, Mo., Edwin Dudley Aber, 100 w, C, "Where Memories Bring Happiness."

WMBI

1080 kc, Chicago, Ill., Moody Bible Institute Radio Station, 5000 w, C, shared, "The West Point of Christian Service."

WMBO

1370 kc, Auburn, N. Y., Radio Service Laboratories, 100 w, E.

WMBQ

1500 kc, Brooklyn, N. Y., Paul J. Gollhofer, 100 w.

WMBR

1370 kc, Tampa, Fla., F. J. Reynolds, 100 w, E, "WMBR, Everything for Radio at Tampa, Fla."

WMC

780 kc, Memphis, Tenn., Memphis Commercial Appeal, Inc., 500 w, C, "WMC, Memphis, Down in Dixie."

WMCA

570 kc, New York, N. Y., Knickerbocker Broadcasting Co., Inc., 500 w, E, "Where the White Way Begins."

WMES

1500 kc, Boston, Mass., Massachusetts Educational Society, 50 w.

WMMN

890 kc, Fairmont, W. Va., Holt Rome Novelty Co., 250 w, E.

WMPC

1500 kc, Lapeer, Mich., First Methodist Protestant Church, 100 w, E, "Where Many Preach Christ."

WMRJ

1420 kc, Jamaica, N. Y., Peter J. Prinz, 10 w, E, "The Gateway of the Sunrise Trail."

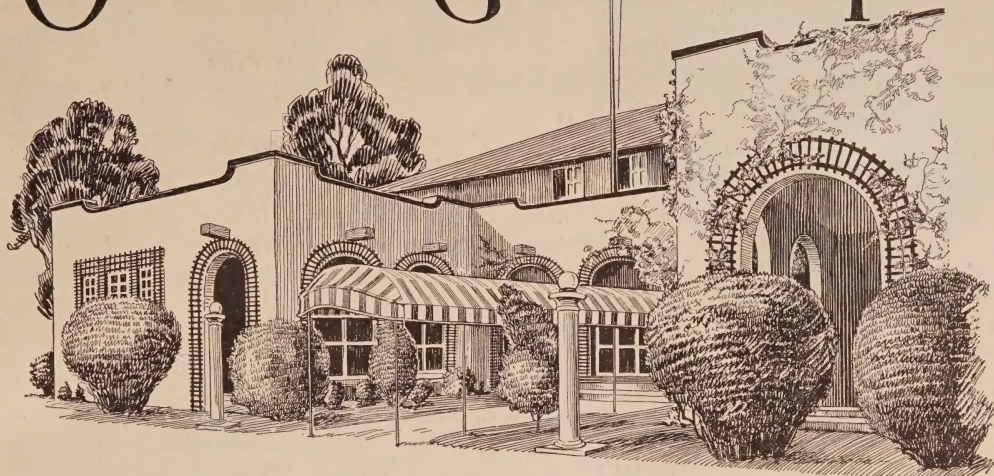
WMSG

1350 kc, New York, N. Y., Madison Square Garden Broadcast Co., 250 w, E.

WMT

600 kc, Waterloo, Iowa, Waterloo Broadcasting Co., 250 w, C.

OSCEOLA GRAMATAN INN



DAYTONA BEACH FLORIDA

ON the outskirts of Daytona Beach in Northern Florida, lies the Osceola Gramatan Inn with its cottages nestled here and there, among the trees of one of Florida's finest orange groves.

The outstanding characteristics of the Inn are its simplicity and good taste, both in architecture and its furnishings. The property is now owned and operated by the Estate of the late Mr. William V. Lawrence, who made a national reputation in the development of the Lawrence Park Properties in Bronxville, New York, and who made the construction and beautification of the Osceola Gramatan both an occupation and recreation.

The Inn is particularly fortunate in its location, lying directly on the Dixie Highway, and adjoining the Daytona Country Club with its eighteen hole golf course, tennis courts and splendid club house, all of which are reached by a few minutes' walk through a forest of Palmetto and Live Oak.

Daytona Beach lies about sixty miles south of St. Augustine within the great orange belt, which is considered the most perfect climate in Florida, having cool winter nights and brilliant sunshiny days. It is a center, also, for motoring over Florida's fine state highways, which radiate north, south and west from Daytona Beach. Immediately at hand is the old famous Daytona-

Ormond Beach, with its twenty miles of perfect surface beside the surf.

Osceola Gramatan Inn provides accommodations for 200 guests, and one of the best chefs in the North is in charge of the cuisine. There are about twenty cottages in the Osceola Grove, each with living room, open fireplace, porch, and complete hotel service. White servants are employed exclusively.

For Golfers the Daytona Country Club offers one of the finest eighteen hole courses in the south, and only a short distance away are the Sea Breeze Golf Course, the Ormond Course, and the College Arms Club at De Land; privileges of all these courses being extended to our guests.

The Halifax Yacht Club is but a short distance, and all the amusements of the city of Daytona Beach are available. There is sea and surf bathing all Winter.

The American Plan prevails with rates that are surprisingly moderate for the type of accommodations. The season is from January 1st to April 1st and the management will welcome your inquiry for a copy of our illustrated folder.

OSCEOLA GRAMATAN INN
DAYTONA BEACH, FLORIDA

Chester A. Wescott, Manager

WNAC

1230 kc, Boston, Mass., The Shepard Norwell Co., 1000 w, E.

WNAD

1010 kc, Norman, Okla., University of Oklahoma 500 w, C, "The Voice of Soonerland."

WNAX

570 kc, Yankton, S. Dak., Gurney Seed & Nursery Co., Dakota Radio Apparatus Co., 1000 w, C.

WNBF

1500 kc, Binghamton, N. Y., Howitt-Wood Radio Co., 50 w, E, "The Voice of the Triple Cities."

WNBH

1310 kc, New Bedford, Mass., New Bedford Broadcasting Co., 100 w, E, shared, "The Gateway to Cape Cod."

WNBJ

1310 kc, Knoxville, Tenn., Lonsdale Baptist Church, 50 w, C.

WNBO

1200 kc, Washington, Pa., J. B. Spriggs, 100 w, E.

WNBR

1430 kc, Memphis, Tenn., John Ulrich, 500 w, C.

WNBW

1200 kc, Carbondale, Pa., Home Cut Glass & China Co., 10 w, E.

WNBX

1200 kc, Springfield, Vt., First Congregational Church Corp., 10 w, E.

WNBZ

1290 kc, Saranac Lake, N. Y., Smith & Mace, 50 w, E.

WNJ

1450 kc, Newark, N. J., Radio Investment Co., 250 w, E, "The Voice of Newark."

WNOX

560 kc, Knoxville, Tenn., Stercki Bros., 1000 w, C, "Smoky Mountain Station."

WNRC

1440 kc, Greensboro, N. C., Wayne M. Nelson, 250 w, E.

WNYC

570 kc, New York, N. Y., Department of Plant & Structures, 500 w, E, "Municipal Broadcasting Station of the City of New York."

WOAI

1190 kc, San Antonio, Texas, Southern Equipment Co., 5000 w, C, "The Winter Playground of America."

WOAN

600 kc, Lawrenceburg, Tenn., J. D. Vaughan, 500 w, C, "Watch Our Annual Normal."

WOAX

1280 kc, Trenton, N. J., Franklyn J. Wolff, 500 w, E, "Trenton Makes, the World Takes."

WOBT

1310 kc, Union City, Tenn., Tittsworth's Radio & Music Shop, 100 w, C.

WOBV

580 kc, Charleston, W. Va., Charleston Radio Broadcasting Co., 250 w, E.

WOC

1000 kc, Davenport, Iowa, Palmer School of Chiropractic, 5000 w, C.

WOCL

1210 kc, Jamestown, N.Y., A. E. Newton, 25 w, E.

WODA

1250 kc, Paterson, N. J., Richard E. O'Dea, 1000 w, E, "The Voice of the Silk City."

WODX

1410 kc, Mobile, Ala., Mobile Brdcastg. Corp., 500 w, C.

WOI

640 kc, Ames, Iowa, Iowa State College, 5000 w, C.

WOKO

1440 kc, Poughkeepsie, N. Y., H. E. Smith and R. M. Curtis, 500 w, E.

WOL

1310 kc, Washington, D. C., American Broadcasting Co., 100 w, E.

WOMT

1210 kc, Manitowoc, Wis., Francis M. Kadow, 100 w.

WOOD

1270 kc, Grand Rapids, Mich., Walter B. Stiles, Inc., 500 w, C, "The Voice of the Whispering Pines."

WOPI

1500 kc, Bristol, Tenn., Wilson Radiophone Service Co., 100 w, E.

WOQ

1300 kc, Kansas City, Mo., Unity School of Christianity, 1000 w, C.

WOR

710 kc, Newark, N. J., L. Bamberger & Co., 5000 w, E.

WORC

1200 kc, Worcester, Mass., A. F. Kleindienst, 100 w, E.

WORD

1480 kc, Chicago, Ill., People's Pulpit Association, 5000 w, C, "The Watch Tower—Radio WORD."

WOS

630 kc, Jefferson City, Mo., State Marketing Bureau, 500 w, C, "Watch Our State."

WOV

1130 kc, New York, N. Y., International Broadcasting Corp., 1000 w, E.

WOW

590 kc, Omaha, Neb., Woodmen of the World, 1000 w, C, "The Omaha Station."

WOWO

1160 kc, Ft. Wayne, Ind., Main Auto Supply Co., 10,000 w, C.

WPAP

See under WQAO.

WPAW

1210 kc, Pawtucket, R. I., Shartenberg & Robinson, 100 w, E, "The City of Diversified Industries."

WPCC

560 kc, Chicago, Ill., North Shore Congregational Church, 500 w, C.

WPCH

810 kc, New York, N. Y., Eastern Broadcasters, Inc., 500 w, E.

WPEN

1500 kc, Philadelphia, Pa., Wm. Penn Broadcasting Co., 100 w, E, "First Wireless School in America."

WPG

1100 kc, Atlantic City, N. J., Municipality of Atlantic City, 5000 w, E.

WPOE

1370 kc, Patchogue, N. Y., Nassau Broadcasting Corp., 30 w, E.

WPOR

See under WTAR.

WPSC

1230 kc, State College, Pa., Pennsylvania State College, 500 w, day, E, "The Voice of the Nittany Lion."

WPTF

680 kc, Raleigh, N. C., Durham Life Insurance Co., 1,000 w, E.

WQAM

560 kc, Miami, Fla., Miami Broadcasting Co., 100 w, E.

WQAN

880 kc, Scranton, Pa., Scranton Times, 250 w, E.

WQAO

1010 kc, New York, N. Y., Calvary Baptist Church, 250 w, E.

WQBC

1360 kc, Utica, Miss., Utica Chamber of Commerce, 300 w, C.

WQBZ

1420 kc, Weirton, W. Va., J. H. Thompson, 60 w, E.

WRAF

1200 kc, La Porte, Ind., The Radio Club, Inc., 100 w.

WRAC

1370 kc, Erie, Pa., C. R. Cummins, 50 w, E.

WRAW

1310 kc, Reading, Pa., Avenue Radio & Electric Shop, 100 w, E, "The Schuylkill Valley Echo."

WRAX

1020 kc, Philadelphia, Pa., Berachah Church, Inc., 250 w, E.

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YOU can enjoy the perfect reproduction and the unusual convenience of this Midget Cone Speaker absolutely free. Manufactured by one of the largest manufacturers in the country, this speaker has innumerable advantages in portability and perfect tone. Ideal for apartment use, or in different rooms of the house, the Midget Speaker is delighting thousands who are now using it.



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Elizabeth, N. J.:

"I received the Midget speaker today. It's great and I am well pleased."

Richard Ogden.

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W. P. McGuire writes: "I received your Midget Speaker and sure was surprised by its performance. I play all distant stations just as good as any speaker I've had, and it performs dandy."

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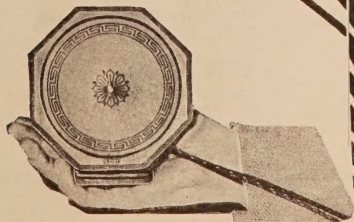
NAME (Print Plainly).....

STREET & NO.....

CITY..... STATE.....

Please Place Your Signature Here.....

My vocation is: ☐ Service and Repair ☐ Radio Engineer ☐ Radio Dealer ☐ Radio Experimenter.



Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

WRBI

1310 kc, Tifton, Ga., Kent's Furniture & Music Store, 20 w, E.

WRBJ

1500 kc, Hattiesburg, Miss., Woodruff Furniture Co., 10 w, C.

WRBL

1200 kc, Columbus, Ga., David Parmer, 50 w, E.

WRBQ

1210 kc, Greenville, Miss., J. Pat Scully, 100 w, C.

WRBT

1370 kc, Wilmington, N. C., Wilmington Radio Association, 100 w, E.

WRBU

1210 kc, Gastonia, N. C., A. J. Kirby Music Co., 100 w, E.

WRC

950 kc, Washington, D. C., Radio Corporation of America, 500 w, E, "The Voice of the Capital."

WREC

600 kc, Whitehaven, Tenn., WREC, Inc., 500 w, C.

WREN

1220 kc, Lawrence, Kan., Jenny Wren Co., 1000 w, C.

WRHM

1250 kc, Minneapolis, Minn., Minnesota Broadcasting Corp., 1000 w, C, "Welcome Rosedale Hospital, Minneapolis."

WRJN

1370 kc, Racine, Wis., Racine Broadcasting Corp., 100 w, C.

WRK

1310 kc, Hamilton, Ohio, S. W. Doron & John C. Slade, 100 w, E, "The Voice of Hamilton."

WRNY

1010 kc, New York, N. Y., Aviation Radio Station, 250 w, E.

WRR

1280 kc, Dallas, Texas, City of Dallas, 500 w, C.

WRUF

830 kc, Gainesville, Fla., University of Florida, 5000 w, E.

WRVA

1110 kc, Richmond, Va., Larus Bros. & Co., Inc., 5000 w, E, "Carry Me Back to Old Virginny."

WSAI

1330 kc, Cincinnati, Ohio, Crosley Radio Corp., 500 w, E, "The Gateway to Dixie."

WSAJ

1310 kc, Grove City, Pa., Grove City College, 100 w, E.

WSAN

1440 kc, Allentown, Pa., Allentown Call Pub. Co., 250 w, E, "We Serve Allentown Nationally."

WSAR

1450 kc, Fall River, Mass., Doughty & Welch Electrical Co., Inc., 250 w, E.

WSAZ

580 kc, Huntington, W. Va., WSAZ, Inc., 250 w, E.

WSB

740 kc, Atlanta, Ga., Atlanta Journal Co., 1000 w, E, "The Voice of the South."

WSBC

1210 kc, Chicago, Ill., World Battery Co., 100 w, C.

WSBT

1230 kc, South Bend, Ind., South Bend Tribune, 500 w, C.

WSDA

See under WSGH.

WSFA

1410 kc, Montgomery, Ala., Montgomery Brdcastg. Co., 500 w, C.

WSGH

1400 kc, Brooklyn, N. Y., Amateur Radio Specialty Co., 500 w.

WSIX

1210 kc, Springfield, Tenn., 638 Tire & Vulcanizing Co., 100 w, C.

WSJS

1310 kc, Winston-Salem, N. C., The Journal Co., 100 w, E.

WSM

650 kc, Nashville, Tenn., National Life & Accident Ins. Co., 5000 w, C, "We Shield Millions."

WSMB

1320 kc, New Orleans, La., Saenger Theaters, Inc., & Maison Blanche Co., 500 w, C, "America's Most Interesting City."

WSMK

1380 kc, Dayton, Ohio, Stanley M. Krohn, Jr., 200 w, C, "The Home of Aviation."

WSOA

1480 kc, Forest Park, Ill., Radiophone Broadcasting Corp., 5000 w, C.

WSPD

1340 kc, Toledo, Ohio, Toledo Broadcasting Co., 500 w, E.

WSSH

1360 kc, Boston, Mass., Tremont Temple Baptist Church, 100 w, E, "Stranger's Sunday Home."

WSUI

600 kc, Iowa City, Iowa, State Univ. of Iowa, 500 w, C, "The Old Gold Studio."

WSUN

See under WFLA.

WSVS

1370 kc, Buffalo, N. Y., Seneca Vocational High School, 50 w, E, "Watch Seneca Vocational School."

WSYR

570 kc, Syracuse, N. Y., Clive B. Meredith, 250 w, E.

WTAD

1440 kc, Quincy, Ill., "Illinois Stock Medicine Broadcasting Corp., 500 w.

WTAG

580 kc, Worcester, Mass., Worcester Telegram Pub. Co., Inc., 250 w, E, "The Voice From the Heart of the Commonwealth."

WTAM

1070 kc, Cleveland, Ohio, WTAM & WEAR, Inc., 50,000 w, E, "The Voice From the Storage Battery."

WTAQ

1330 kc, Eau Claire, Wis., Gillette Rubber Co., 1000 w, C.

WTAR

780 kc, Norfolk, Va., WTAR Radio Corp., 500 w, E.

WTAW

1120 kc, College Station, Texas, Agri. & Mech. College of Texas, 500 w, C.

WTAX

1210 kc, Streator, Ill., Williams Hardware Co., 50 w.

WTBO

1420 kc, Cumberland, Md., Associated Brdcastg. Corp., 50 w, E.

WTFI

1450 kc, Toccoa, Ga., Toccoa Falls Institute, 250 w, E.

WTIC

1060 kc, Hartford, Conn., Travels Broadcasting Service Corp., 50,000 w, E, "The Insurance City."

WTMJ

620 kc, Milwaukee, Wis., Milwaukee Journal, 1000 w, C.

WTNT

1490 kc, Nashville, Tenn., Tenn. Pub. Co., 5000 w, C.

WTOC

1260 kc, Savannah, Ga., Savannah Broadcasting Corp., 500 w, E.

WWAE

1200 kc, Hammond, Ind., Hammond-Calumet Broadcasting Corp., 100 w.

WWJ

920 kc, Detroit, Mich., Evening News Assn., 1000 w, E.

WWL

850 kc, New Orleans, La., Loyola University, 5000 w, C.

WWNC

570 kc, Asheville, N. C., Citizens Broadcasting Co., 1000 w, E.

WWRL

1500 kc, Woodside, N. Y., Long Island Broadcasting Corp., 100 W.

WWVA

1160 kc, Wheeling, W. Va., West Virginia Broadcasting Corp., 5000 w, E.

Call	Town	Call	Town	Call	Town	Call	Town
KCRB—Enid, Okla.	KGY—Lacey, Wash.	WRAX—Wilkes-Barre, Pa.	WHAS—Louisville, Ky.	WMCA—New York, N. Y.	WMCA—New York, N. Y.	WMCA—New York, N. Y.	WMCA—New York, N. Y.
KDB—Santa Barbara, Calif.	KH—Los Angeles, Calif.	WRBC—Brooklyn, N. Y.	WHAT—Philadelphia, Pa.	WMES—Boston, Mass.	WMES—Boston, Mass.	WMES—Boston, Mass.	WMES—Boston, Mass.
KD—Spokane, Wash.	KHQ—Spokane, Wash.	WRB—Richmond, Va.	WHB—Troy, N. Y.	WMH—Fairfax, Va.	WMH—Fairfax, Va.	WMH—Fairfax, Va.	WMH—Fairfax, Va.
KDKA—East Pittsburgh, Pa.	KICK—Red Oak, Ia.	WRBM—Chicago, Ill.	WHB—Kansas City, Mo.	WMR—Lapeer, Mich.	WMR—Lapeer, Mich.	WMR—Lapeer, Mich.	WMR—Lapeer, Mich.
KDLR—Davis Lake, N. D.	KID—Idaho Falls, Idaho	WRB—Roselle, N. J.	WHBC—Canton, Ohio	WMRI—Jamaica, N. Y.	WMRI—Jamaica, N. Y.	WMRI—Jamaica, N. Y.	WMRI—Jamaica, N. Y.
KDRE—Denver, Colo.	KIDP—Boise, Idaho	KIC—Charlotte, N. C.	WHB—Cleveland, Ohio	WMR—New York, N. Y.	WMR—New York, N. Y.	WMR—New York, N. Y.	WMR—New York, N. Y.
KECA—Los Angeles, Calif.	KIK—Yakima, Wash.	WRB—Ponca City, Okla.	WHB—Rock Island, Ill.	WMR—Waterloo, N. Y.	WMR—Waterloo, N. Y.	WMR—Waterloo, N. Y.	WMR—Waterloo, N. Y.
KEK—Beverly Hills, Calif.	KJBS—San Francisco, Calif.	WRB—Bay City, Mich.	WHB—Sheboygan, Wis.	WMR—Washington, Pa.	WMR—Washington, Pa.	WMR—Washington, Pa.	WMR—Washington, Pa.
KEW—Burbank, Calif.	KJR—Seattle, Wash.	WRB—Boston, Mass.	WHB—Memphis, Tenn.	WMR—Memphis, Tenn.	WMR—Memphis, Tenn.	WMR—Memphis, Tenn.	WMR—Memphis, Tenn.
KEP—Portland, Ore.	KJLN—Blytheville, Ark.	WRB—Chicago, Ill.	WHB—Anderson, Ind.	WMR—Portland, Ore.	WMR—Portland, Ore.	WMR—Portland, Ore.	WMR—Portland, Ore.
KEP—Lincoln, Neb.	KJLN—Ogden, Utah	WRB—Fort Lee, N. J.	WHB—Green Bay, Wis.	WMR—Yonkers, N. Y.	WMR—Yonkers, N. Y.	WMR—Yonkers, N. Y.	WMR—Yonkers, N. Y.
KEP—Great Falls, Mont.	KJLN—Minot, N. D.	WRB—New York, N. Y.	WHB—Calumet, Mich.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KEP—Sacramento, Calif.	KJLN—Little Rock, Ark.	WRB—New York, N. Y.	WHB—Gloucester, Mass.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Everett, Wash.	KJLN—Oakland, Calif.	WRB—New York, N. Y.	WHB—Minneapolis, Minn.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Brookings, S. D.	KJLN—Dumont, N. J.	WRB—Birmingham, Ala.	WHB—Tupper Lake, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Denver, Colo.	KJLN—DuPont, Colo.	WRB—Wilkes-Barre, Pa.	WHB—Rochester, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Boone, Iowa	KJLN—Shenandoah, Ia.	WRB—Tilton, N. H.	WHB—Greene, N. H.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Wichita, Kans.	KJLN—Springfield, Mo.	WRB—Wellesley Hills, Mass.	WHB—Bluefield, W. Va.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Garrison, Calif.	KJLN—Medford, Ore.	WRB—Charlotte, N. C.	WHB—Cleveland, Ohio	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Los Angeles, Calif.	KJLN—Ingewood, Calif.	WRB—Worcester, Mass.	WHB—Newark, N. J.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Portland, Ore.	KJLN—Presno, Calif.	WRB—Boston, Mass.	WHB—Des Moines, Iowa	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Spokane, Wash.	KJLN—Clay Center, Neb.	WRB—Waco, Texas, Conn.	WHB—Harrisburg, Pa.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Fond du Lac, Wis.	KJLN—Tacoma, Wash.	WRB—Canton, N. Y.	WHB—Pittsburgh, Pa.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Marshalltown, Iowa.	KJLN—St. Louis, Mo.	WRB—Columbus, Ohio	WHB—Madison, Wis.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Oklahoma City, Okla.	KJLN—Hollywood, Calif.	WRB—Lincoln, Neb.	WHB—Elkins Park, Pa.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Corvallis, Ore.	KJLN—Denver, Colo.	WRB—Chicago, Ill.	WHB—Jackson, Mich.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Grand Forks, N. D.	KJLN—Portland, Ore.	WRB—London, England	WHB—Steuensville, Ohio	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Portland, Ore.	KJLN—KOCW—Chickasha, N. M.	WRB—Baltimore, Md.	WHB—Elizabeth, N. J.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Port Dodge, Ia.	KJLN—Reno, Nev.	WRB—Asbury Park, N. J.	WHB—Piquette, Mich.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Fort Collins, Colo.	KJLN—Council Bluffs, Ia.	WRB—Rapid City, S. D.	WHB—Topeka, Kans.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Greeley, Colo.	KJLN—KOFN—Portland, Ore.	WRB—Philadelphia, Pa.	WHB—Utica, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Milford, Kans.	KJLN—Seattle, Wash.	WRB—Waco, Tex.	WHB—Bridgeport, Conn.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Lawrence, Kan.	KJLN—KOFN—Seattle, Wash.	WRB—Carthage, Ill.	WHB—St. Louis, Mo.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Chicago, Ill.	KJLN—KOFN—Marshallfield, Ore.	WRB—Zion, Ill.	WHB—Urbana, Ill.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Rockford, Ill.	KJLN—KOFN—Phoenix, Ariz.	WRB—Baltimore, Md.	WHB—Wilmet, Ill.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Galveston, Tex.	KJLN—KOFN—Seattle, Wash.	WRB—Springfield, Ill.	WHB—Wilmington, Del.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.	WMR—Buffalo, N. Y.
KFB—Northfield, Minn.	KJLN—KOFN—Pres						

U. S. Broadcasting Stations by Frequencies

550 Kilocycles, 545.1 Meters:

KOAC, WGR, WEAQ, WKRC, KFUO, KSD, KFDY, KFYR.

560 Kilocycles, 535.4 Meters:

WLIT, WFI, KFDL, WNOX, KTAB, KLZ, WIBO, WEBW, WPCC, WQAM.

570 Kilocycles, 526.0 Meters:

WYNC, WMCA, WSYR, WMAC, WKBN, WYNC, KGKO, WNAX, KXA, KMTR.

580 Kilocycles, 516.9 Meters—Canadian Shared:

WTAG, WOBW, WSAZ, KGFX, KSAC, WIBW.

590 Kilocycles, 508.2 Meters:

WEEI, WEMC, WCAJ, WOW, KHQ.

600 Kilocycles, 499.7 Meters—Canadian Shared:

WTIC, WCAO, WREC, WOAN, KFSD, WCAC, WMT, WSUI.

610 Kilocycles, 491.5 Meters:

WFAN, WIP, WDAF, KERC.

620 Kilocycles, 483.6 Meters:

WLBZ, WTMJ, KGW, WJAY, KREP, WFLA, WSUN.

630 Kilocycles, 475.9 Meters—Canadian Shared:

WMAL, WOS, KFRU, WGBF.

640 Kilocycles, 468.5 Meters:

WAIU, KFI, WOI.

650 Kilocycles, 461.3 Meters:

WSM.

660 Kilocycles, 454.3 Meters:

WEAF, WAAW.

670 Kilocycles, 447.5 Meters:

WMAQ.

680 Kilocycles, 440.9 Meters:

WPTE, KPO, KFQ.

690 Kilocycles, 434.5 Meters—Canadian Wave:

700 Kilocycles, 428.3 Meters:

WLW.

710 Kilocycles, 422.3 Meters:

WOR, KEJK, WHB.

720 Kilocycles, 416.4 Meters:

WGN, WLBB.

730 Kilocycles, 410.7 Meters—Canadian Wave:

740 Kilocycles, 405.2 Meters:

WSB, KMMJ.

750 Kilocycles, 399.8 Meters:

WJR.

760 Kilocycles, 394.5 Meters:

WJZ, WEW.

770 Kilocycles, 389.4 Meters:

KFAB, WBBM, WJBT.

780 Kilocycles, 384.4 Meters—Canadian Shared:

WTAR, WPOR, KELW, KTM, WMC, WEAN.

790 Kilocycles, 379.5 Meters:

WGY, KGO.

800 Kilocycles, 374.8 Meters:

WBAP, WFAA.

810 Kilocycles, 370.2 Meters:

WPCB, WCCO.

820 Kilocycles, 365.6 Meters:

WHAS.

830 Kilocycles, 361.2 Meters:

KOA, WHDH, WRUF.

840 Kilocycles, 356.9 Meters—Canadian Wave:

850 Kilocycles, 352.7 Meters:

KWKH, WWL.

860 Kilocycles, 348.6 Meters:

WBOQ, WABC, KFQZ, KMO, KFPY.

870 Kilocycles, 344.6 Meters:

WLS, WENR, WBCN.

880 Kilocycles, 340.7 Meters—Canadian Shared:

WQAN, WGBI, WCOC, KLX, KPOF, KFKA.

890 Kilocycles, 336.9 Meters—Canadian Shared:

WJAR, WMMN, WMAZ, WGST, KGJF, WILL, KUSD, KFNH, WKQA.

900 Kilocycles, 331.1 Meters:

WFBL, WMAK, WKY, WLBB, KHJ, KSEI, KGBU, WJAX.

910 Kilocycles, 329.5 Meters—Canadian Wave:

920 Kilocycles, 325.9 Meters:

WWJ, KPRC, WAAF, WBSO, KVI, KFXE, KFEL.

930 Kilocycles, 322.4 Meters—Canadian Shared:

WIBG, WDBJ, WBRC, KGBZ, KMA, KFWM, KFWI.

940 Kilocycles, 319 Meters:

WCSH, WFIW, KOIN, KGU, WHA, WDAY.

950 Kilocycles, 315.6 Meters:

WRC, KMBC, KFWB, KGH.

960 Kilocycles, 312.3 Meters—Canadian Wave:

970 Kilocycles, 309.1 Meters:

KOMO, KJR.

980 Kilocycles, 305.9 Meters:

KDKA.

990 Kilocycles, 302.8 Meters:

WBZ, WBZA.

1000 Kilocycles, 299.8 Meters:

WHO, WOC, KFVD.

1010 Kilocycles, 296.9 Meters—Canadian Shared:

WQAO, WPAP, WHN, WRNY, KGGF, WNAD, KQW.

1020 Kilocycles, 293.9 Meters:

KYW, KFKX, KYWA, WRAX.

1030 Kilocycles, 291.1 Meters—Canadian Wave:

1040 Kilocycles, 288.3 Meters:

WKEN, WKAR, KTHS, KRLD.

1050 Kilocycles, 285.5 Meters:

KNN, KFKB.

1060 Kilocycles, 282.8 Meters:

WBAL, WJAG, KWJJ, WTIC.

1070 Kilocycles, 280.2 Meters:

WAAT, WTAM, WEAR, WCAZ, WDW, KJBS.

1080 Kilocycles, 277.6 Meters:

WBT, WCB, WMBI.

1090 Kilocycles, 275.1 Meters:

KMOX, KFQA.

1100 Kilocycles, 272.6 Meters:

WPG, WLWL, KGDM.

1110 Kilocycles, 270.1 Meters:

WRVA, KSOO.

1120 Kilocycles, 267.7 Meters—Canadian Shared:

WTAW, KUT, WISN, WHAD, KFSG, KMIC, KRSC, WDEL, WDBO.

1130 Kilocycles, 265.3 Meters:

WOV, KSL, WJJJ.

1140 Kilocycles, 263.0 Meters:

WAFI, KVOO.

1150 Kilocycles, 260.7 Meters:

WHAM.

1160 Kilocycles, 258.5 Meters:

WWVA, WOWO.

1170 Kilocycles, 256.3 Meters:

WCAU, KNTN.

1180 Kilocycles, 254.1 Meters:

WGBS, KEX, KOB, WGDY, WHDI.

1190 Kilocycles, 252.0 Meters:

WICC, WOAI.

1200 Kilocycles, 249.9 Meters—Canadian Shared:

WABI, WNBX, WORC, WIBX, WHBC, WLAP, WLBB, WNB, WKJC, WNBW, WABZ, WJBW, WBBY, WBBZ, WFB, WRBL, KGC, WJBC, WJBL, WWA, WRAF, WMT, KFJB, WCAT, KGDY, KFWF, KGDE, KGKF, WCLO, WHBY, KXO, KSMR, WIL, KFH, KVO, KGY, WMA, KVG, KGEK, KGEW, KGI, WCA, WCD.

1210 Kilocycles, 247.8 Meters—Canadian Shared:

WJBL, WGBB, WCOH, WOCL, WLCL, WPAW, WDFW, WLSI, WMAN, WJW, WEEB, WBA, WJBL, WMBG, WSLX, WRBU, WJBY, WRBO, WGM, KWEA, KDLR, KGC, KFOR, WHBU, KFVS, WBO, WCRW, WEDC, WBS, WTAX, WHBF, WIRA, WMT, KPO, KPCB, WSBC, KFDN, KMJ, KFXM, KPCC, KGFJ.

1220 Kilocycles, 245.6 Meters:

WCAD, WCAE, WREN, KFKU.

1230 Kilocycles, 243.8 Meters:

WNAC, WBIS, WPSC, WSBT, WFBN, KFIO, KQD.

1240 Kilocycles, 241.8 Meters:

WGHP, WJAD, KSAT, WDAE.

1250 Kilocycles, 239.9 Meters:

WGCP, WODA, WAAM, WLB, WGMS, WRHM, KFMX, WCAL, KIDO, WFOX, WDSU.

1260 Kilocycles, 238.0 Meters:

WLBW, KWWG, KRGV, KOIL, KVOA, WTOC.

1270 Kilocycles, 236.1 Meters:

WEAI, WASH, WOOD, KWLC, KGCA, KTW, KOL, KFUM, WFB, WJDX.

1280 Kilocycles, 234.2 Meters:

WCAM, WCAP, WOAX, WDD, WRR, WCFL.

1290 Kilocycles, 232.4 Meters:

WNEB, WJAS, KTS, KFUL, KLCN, KDYL, WBC.

1300 Kilocycles, 230.6 Meters:

WBBR, WHAP, WEVD, WHAZ, KPH, KGFE, KTBL, KFJR, KTB, WIOD, WMBF, WOQ.

1310 Kilocycles, 228.9 Meters:

WKAV, WEBR, WNBH, WOL, WGH, WRK, WAGM, WFDE, WHAT, WFKD, WFRG, WRW, WGA, WSAJ, WBRE, WKBC, KGHG, WOBT, WNB, KRMD, KFFM, WDAH, KPFL, KFXR, WKBS, WRBI, WCLS, WKBB, KWCR, KEJY, KFCG, WBO, WJAK, WLBC, WBU, KFBK, KTS, KGEZ, KFUP, KFKJ, KFBK, KGEZ, KMD, KTS, KGCX, WJAC, WSJS, KXRO, KGF.

1320 Kilocycles, 227.1 Meters:

WADC, WSMB, KID, KGIO, KGHF.

1330 Kilocycles, 225.4 Meters:

WDR, WTAQ, KSCJ, WSAI, KGB.

1340 Kilocycles, 223.7 Meters:

WSPD, KFPW, WCOA.

1350 Kilocycles, 222.1 Meters:

WBNY, WMSG, WCD, WKBQ, KWK.

1360 Kilocycles, 220.4 Meters:

WLEX, WQBC, WJCS, WGES, KFB, KGIR, KGER, KPSN, WMAF, WSSH.

1370 Kilocycles, 218.8 Meters:

WMBO, WSVS, WCBM, WBB, WHBD, WJBK, WIBM, WRK, WELK, WJBO, WHBO, WRBT, KFGF, KIT, KGCI, KGR, KFJZ, KGKL, KFLX, WFB, KGDA, KZM, KRE, WPOE, KFL, KWKC, KGB, WRIN, KGA, KLO, KOH, KVL, KFJ, KGL, KGM, WHDF, KOOS, WGL, KFJM, KCRC, WEHC, WMBR.

1380 Kilocycles, 217.3 Meters:

KOV, KSO, WKBH, WSMK.

1390 Kilocycles, 215.7 Meters:

WHK, KLRA, KUOA, KOW, KOY.

1400 Kilocycles, 214.2 Meters:

WCGU, WSGH, WSDA, WLTH, WBB, WDMA, WKBF, KOCW, WBAA, KWS.

1410 Kilocycles, 212.6 Meters:

KGRS, WDAF, KFLV, WHBL, WBCM, WODX, WSPA.

1420 Kilocycles, 211.1 Meters:

WMRJ, WTBO, WKBL, WBR, WEDH, WMBC, WKBP, WQBZ, KGEF, WHIS, KTA, KTUE, KFY, KICK, WIAS, KGGC, WLB, WMBH, KFJZ, KORE, WILM, KGW, KGKX, WLEY, KPOW, KLP, KXL, WHDL, WHFC, WEHS, KFOU, KFXD, KGIX, KFF.

1430 Kilocycles, 209.7 Meters:

WBRL, WHP, WCAH, WGBC, WNBR, WBAK, KECA.

1440 Kilocycles, 208.2 Meters:

WHFC, WABO, WOKO, WCB, WNK, WTAD, WMBD, KLS, WSA.

1450 Kilocycles, 206.8 Meters:

WBMS, WNI, WBS, WKBO, WSAR, WFJC, WTEI, KTBS, WCSO.

1460 Kilocycles, 205.4 Meters:

WJSV, KSTP.

1470 Kilocycles, 204.0 Meters:

WKBW, KFJF, KGA.

1480 Kilocycles, 202.6 Meters:

WJAZ, WORD, WCKY, WSOA.

1490 Kilocycles, 201.6 Meters:

WBAW, WLAC, KPWF, WNT.

1500 Kilocycles, 199.9 Meters:

WMBA, WLOE, WMES, WNB, WMBO, WLB, WWR, WKBZ, WMPC, WOPL, WPE, WRBJ, KGB, KGH, WKBV, KPJM, KYEP, KDB, KUJ, KGI.

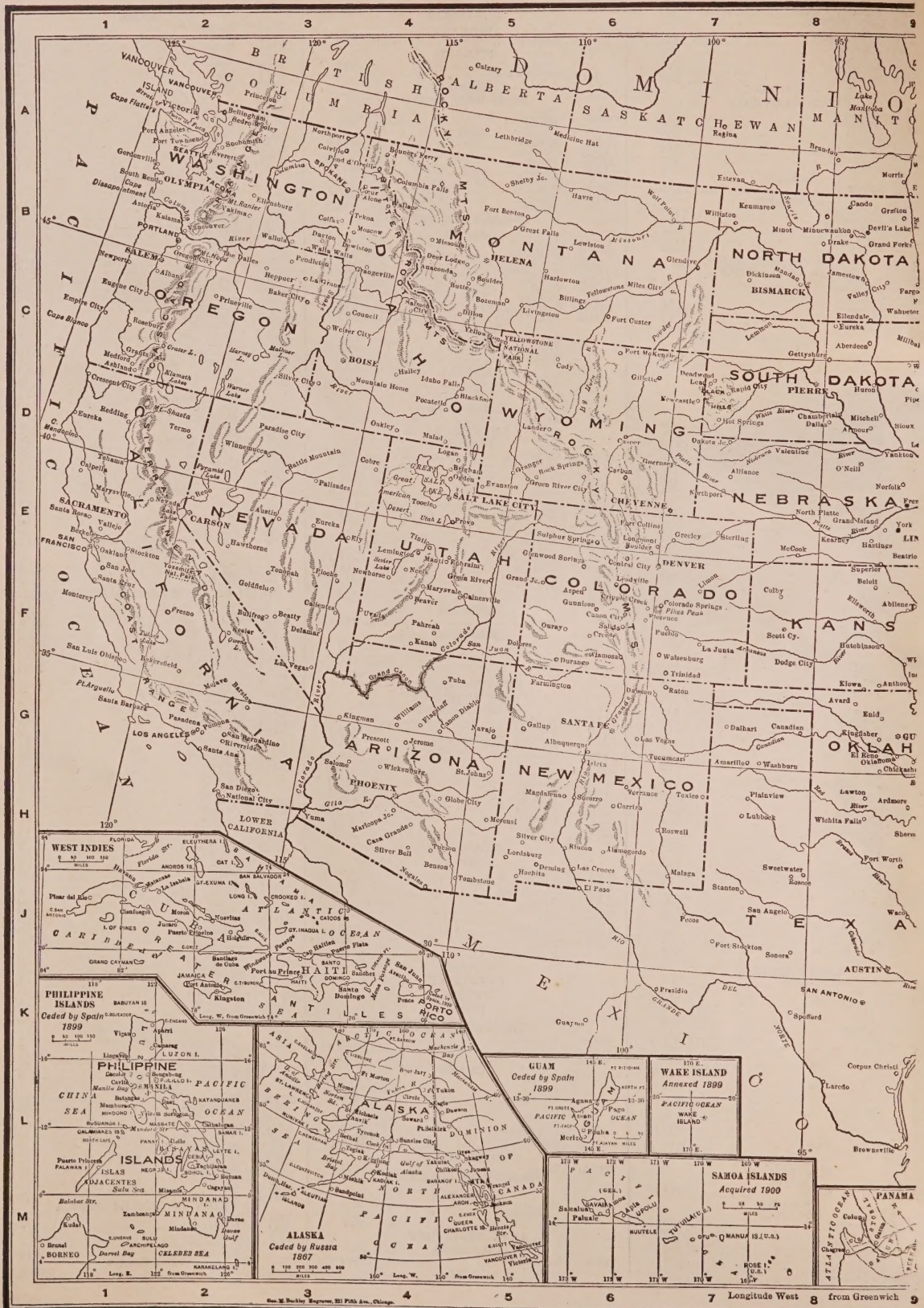
U. S. Broadcasting Stations Listed by States

ALABAMA Birmingham, WBRC, WKBC. WAFB Gadsden, WJBY Mobile, WODX Montgomery, WSFA	Pocatello, KSEI Sandpoint, KGKX Twin Falls, KGKQ	Springfield, WBZ Wellesley Hills, WBRO Worcester, WTAG, WORC	Long Island City, WLBK New York, WBNY, WHN, WJZ, WKBC, WMCA, WJSG, WNYC, WPCB, WNY, WABC, WOV, WQAO, WLWL, WBOQ, WQDA, WJAF, WGBS, WHAP, WPAP Patchogue, WPOB Poughkeepsie, WOKO Rochester, WHAM, WHEO Rossville, WBBR Saranac Lake, WNBZ Schenectady, WGY Syracuse, WFRL, WSYR Tupper Lake, WHDL Troy, WHAZ Utica, WIBX Woodhaven, WEYD Woodside, WWRL Yonkers, WCOH	SOUTH CAROLINA Charleston, WBYY
ALASKA Anchorage, KFQD Ketchikan, KGBU	ILLINOIS Carthage, WCAZ Chicago, KYYW, WAAF, WCPL, WCRW, WEDC, WENR, WGES, WKBI, WPCO, WGN, WMAQ, WMBL, WBBM, KYWA, WSHC, WBCN, WBLO, WJAZ, WJBT, WLBB, WLS, WORD, KFKX Cicero, WHFO Decatur, WJBL Evanston, WEHS Forest Park, WSOA Galesburg, WKBS Harrisburg, WBBQ Joliet, WLS, WKBB La Salle, WIBC Moline, WJPD Peoria Heights, WMBD Quincy, WTAD Rockford, KFLV Rock Island, WHBF Springfield, WGBS Streator, WTAX Tuscola, WJZ Urbana, WILL Zion, WCBD	MICHIGAN Battle Creek, WKBP Bay City, WBCM Berrien Springs, WEMC Calumet, WHDF Detroit, WMBC, WWJ, WJR, East Lansing, WKAR Flint, WFDF Grand Rapids, WASH, WOOD Jackson, WIBM Lapeer, WMPC Ludington, WKBZ Royal Oak, WAGM Ypsilanti, WJBK	NORTH CAROLINA Asheville, WUNC Charlotte, WBT Gastonia, WRBQ Greensboro, WRDQ Raleigh, WPTF Wilmington, WRBT Winston-Salem, WSJS	SOUTH DAKOTA Brookings, KFDY, KGOR Dell Rapids, KGDA Oelrichs, KGDY Pierre, KGFX Rapid City, WCAT Sioux Falls, WSCB Vermillion, KUSD Watertown, KGCR Yankton, WNAK
ARIZONA Flagstaff, KFXN Phoenix, KREI, KOY Prescott, KPJM Tucson, KGAR, KVOA	INDIANA Anderson, WHBU Brookville, WKBV Culver, WCMC Evansville, WGBF Fort Wayne, WGL, WOWO Gary, WZZM Hammond, WMAE Indianapolis, WFBM, WFBF Lafayette, WIAA La Porte, WRAF Marion, WIAK Muncie, WIBC South Bend, WSBT Terre Haute, WBOW	MINNESOTA Anoka, WCCO Collegeville, WFBJ Fergus Falls, KGDE Hallock, KGPK Minneapolis, WDDY, WHDI, WLB, WRHM, WCCO, WGMS Northfield, KFMX, WCAL St. Paul, KSTP	NORTH DAKOTA Bismarck, KFYR Devils Lake, KDLR Fargo, WDAY Grand Forks, KFJM Mandan, KGCU Minot, KLPD	TENNESSEE Bristol, WOPI Chattanooga, WDDO Knoxville, WFBZ, WNBZ, WNOX Lawrenceburg, WOAN Memphis, WGBZ, WHBQ, WMC, WNNR Nashville, WRAW, WLAC, WSM, WNTN Springfield, WWSN Union City, WORT Whitehaven, WREC
ARKANSAS Fayetteville, KLCN Fayetteville, KUOA Hot Springs, KTHS Little Rock, KLR, KGHI, KGJF McGehee, KGGB Siloam Springs, KFPW	KANSAS Ames, WOI Boone, KFSD Cedar Rapids, KWOR Clarinda, KSO Council Bluffs, KOIL Davenport, WOC Decatur, KGCA, KWLO Des Moines, WHO Ft. Dodge, KFTY Iowa City, WSIU Marshalltown, KFJB Muscatine, KNTT Ottumwa, WIAS Red Oak, KICK Shenandoah, KPNF, KMA Sioux City, KSCJ Waterloo, WMT	MISSISSIPPI Greenville, WRBQ Gulfport, WGCN Hattiesburg, WBJJ Jackson, WJDX Meridian, WCOO Utica, WQBO	OHIO Akron, WFCJ Canton, WHBC Cambridge, WERE Cincinnati, WKRO, WSAI, WLW Cleveland, WYAR, WHK, WJAZ, WTAM Columbus, WAU, WCAH, WEAQ, WMAN Dayton, WSM Hamilton, WRK Mansfield, WJW Steubenville, WWSO Mt. Orab, WHBD Springfield, WGSB Tallmadge, WADC Youngstown, WBBN	TEXAS Abilene, KFTO Amarillo, KGHS, WDAQ Austin, KUT Beaumont, KFDM Brownsville, KRWG Brownwood, KGBB College Station, WTAW Corpus Christi, KGBT Dallas, KRID, WFAA, WRR Dublin, KFTI El Paso, WDAH, KTSN Fort Worth, KFJZ WBAP, KSAT Galveston, KFLX, KFOL Greenville, KRGV Harlingen, KRGV Houston, KPRC, KTUE Richmond, KRGV San Angelo, KGPI, KGKI San Antonio, KGBT, KTAP, KSA, WDAI Waco, WJAD Wichita Falls, KGKO
CALIFORNIA Berkeley, KRE Berkeley Hills, KEJX Burbank, KELW Culver City, KPVD El Centro, KXO Fresno, KMJ Hayward, KZM Hollywood, KMTS, KNX, KFWB Holy City, KFQU Inglewood, KMIC Long Beach, KFQX, KGER Los Angeles, KFI, KFSG, KGEF, KGFI, KHJ, KTHI, KPCA, KFQZ Oakland, KGO, KLS, KLB, KLAB Pasadena, KPCC, KPNS Richmond, KPWM Sacramento, KPIK San Bernardino, KFKM San Diego, KSD, KGB San Francisco, KFO, KFWL, KFSB, KQW, KGGC San Jose, KQW Santa Barbara, KDB Santa Maria, KSMR Santa Monica, KTM Stockton, KGDH, KVG Westminster, KPWF	COLORADO Colorado Springs, KPFM Denver, KFPL, KFUP, KFXF, KOA, KPBF Dupont, KXJ Edwards, KFLZ Fort Morgan, KGEW Greeley, KPFA Gunnison, KPFA Pueblo, KGHF Trinidad, KGIV Yuma, KGEK	MISSOURI Cape Girardeau, KFVS Columbia, KFRU Jefferson City, WBJJ Joplin, WMBH Kansas City, KWKC, WDAF, WQO, WHR, KCMY St. Joseph, KCB, KFEQ St. Louis, KFWF, KSD, KWK, WEW, WIL, KMOX, KFUO, WMAI, KFQA	OKLAHOMA Alva, KGFF Chickasha, KOOW Enid, KCRG Norman, WNAD Oklahoma City, KFJF, KFXR, KOCB, KQGF, WKY Picher, KGFF Ponca City, WBBZ Tulsa, KVOO	UTAH Ogden, KLO Salt Lake City, KDTL, KSL
CONNECTICUT Bridgeport, WICO Hartford, WTIC New Haven, WDRD Storrs, WCAO	KANSAS Kansas City, WLBZ Lawrence, KFKU, WREN Manhattan, KSAC Milford, KPRB Topeka, KTRH Wichita, KFH	NEBRASKA Clay Center, KMJJ Lincoln, KFAB, KFOP, WOAJ Norfolk, WGAN Omaha, WAAW, WQW Ravenna, KGFV York, KGBZ	OREGON Astoria, KFJI Corvallis, KOAC Eugene, KORE Marshfield, KOOS Medford, KMED Portland, KEX, KOIN, KFIF, KFJH, KGW, KTRB, KVEP, KWIJ, KXL	VERMONT Burlington, WCAX Springfield, WNBX
DELAWARE Wilmington, WDEL, WILM	KENTUCKY Covington, WCKY Hopkinsville, WFTW Louisville, WHAS, WLAP	NEVADA Las Vegas, KGIX Reno, KOH	PENNSYLVANIA Allentown, WCEA, WSAW Altoona, WFBG Carlisle, WNBW East Pittsburgh, KDKA Elkins Park, WIRG Erie, WEDH, WRAK Frankfort, WFKD Grove City, WSAJ Harrisburg, WHAK, WOOD Johnstown, WJAC Lancaster, WGAL, WKJC Le Moyne, WJBU Lewisburg, WJRU Oil City, WLWB Philadelphia, WCAU, WFL, WITF, WLIT, WRAX, WPEN, WFAN, WELK, WHAT Pittsburgh, KQV, WCAE, WJAZ Reading, WRAW Scranton, WGBI, WOAN, State College, WPSG Wilkes-Barre, WRAX, WBRE Washington, WNBO	WASHINGTON Aberdeen, KXRO Bellingham, KVOX Everett, KFIJ Lacey, KGY Longview, KJL Pullman, KWSC Seattle, KFI, KQOW, KPO, KJR, KMO, KPBC, KRSC KTW, KVL Spokane, KFTO, KFTY, KGA, KHQ Tacoma, KAO Yakima, KMT
DISTRICT OF COLUMBIA Washington, NAA, WMAL, WRC, WOL	KANSAS Kansas City, WLBZ Lawrence, KFKU, WREN Manhattan, KSAC Milford, KPRB Topeka, KTRH Wichita, KFH	NEW HAMPSHIRE Laconia, WKAV Tilton, WBRL	PORTO RICO San Juan, WKAQ	WEST VIRGINIA Bluefield, WHIS Charleston, WOBV Fairmont, WMMN Huntington, WSAZ Wheeling, WYVA Wiarton, WQBZ
FLORIDA Clearwater, WFLA, WSUN Gainesville, WRUF Jacksonville, WJAX Miami Beach, WIOD, WMBF, WQAM Orlando, WDRB Pensacola, WCOA Tampa, WDAE, WMBR,	MAINE Bangor, WABI, WLBZ Portland, WCSH	NEW JERSEY Asbury Park, WCAP Atlantic City, WFG Camden, WGAN Elizabeth, WBBS Fort Lee, WBMS Jersey City, WJAT, WKRO Newark, WAAW, WGPC, WNJ, WOR Paterson, WJFA Red Bank, WJBI Trenton, WOAN	NEW MEXICO Albuquerque, KGGH El Paso, KRGV State College, KOB	WISCONSIN Beloit, WEDW Eau Claire, WTAQ Fond Du Lac, KFTZ Green Bay, WBYY Kenosha, WCLD La Crosse, WKRB Madison, WHA, WIBA Manitowish, WMTV Milwaukee, WHAD, WISN, WTMJ Poyette, WTRU Racine, WRJN Sheboygan, WBRB Stevens Point, WLBL Superior, WEEB
GEORGIA Atlanta, WGST, WSB Columbus, WBLB Macon, WMAZ Savannah, WTOG Tifton, WRBI Toccoa, WTFI	MARYLAND Baltimore, WCAO, WCBM, WBAL, WFBZ Cumberland, WTBO	NEW YORK Auburn, WMRO Binghamton, WNBZ Brooklyn, WBBC, WLTH, WMBQ, WSGH, WSDA Buffalo, WBBR, WGBW, WKEN, WSYR, WMAK Canton, WCAD Cazenovia, WMAF Coney Island, WCGU Freeport, WGBZ Ithaca, WLCT, WEAI Jamaica, WMRJ Jamestown, WOCL	PORTO RICO San Juan, WKAQ	YOMINGO Casper, KDFN
HAWAII Honolulu, KGU	MASSACHUSETTS Boston, WBZA, WEEL, WNAC, WSSH, WMES, WBIS, Fall River, WSAK Gloucester, WPHH Lexington, WLEX, WLEY New Bedford, WNBH	NEW YORK Auburn, WMRO Binghamton, WNBZ Brooklyn, WBBC, WLTH, WMBQ, WSGH, WSDA Buffalo, WBBR, WGBW, WKEN, WSYR, WMAK Canton, WCAD Cazenovia, WMAF Coney Island, WCGU Freeport, WGBZ Ithaca, WLCT, WEAI Jamaica, WMRJ Jamestown, WOCL	PORTO RICO San Juan, WKAQ	YOMINGO Casper, KDFN

United States				Call				Owner			
Call	Owner	Kilowatts	Meters	W8XX	Westinghouse, East Pittsburgh, Pa.	17,780	16.87	W8XX	Westinghouse, East Pittsburgh, Pa.	21,540	13.93
W2XAC	General Electric, Schenectady, N. Y.	8,690	34.5	W9XA	General Electric, Denver, Colo.	6,040	49.67				
W2XAD	General Electric, Schenectady, N. Y.	15,340	19.46	W9XQA	Chicago Daily News, Chicago, Ill.	6,060	49.5				
W2XAF	General Electric, Schenectady, N. Y.	9,530	31.48	W9XQ	Monsi Motor Oil Co., Council Bluffs, Iowa	6,060	49.53				
W2XAL	Aviation Radio, Cotesville, N. J.	6,040	49.67	W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	11,500	25.42				
W2XAL	Aviation Radio, Cotesville, N. J.	11,800	25.42	W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	11,500	25.42				
W2XAL	Aviation Radio, Cotesville, N. J.	15,250	19.67	W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	11,500	13.95				
W2XAL	Aviation Radio, Cotesville, N. J.	21,460	13.97								
W2XAL	Aviation Radio, Cotesville, N. J.	6,020	49.83								
W2XBR	Baruchrome Corporation, New York, N. Y.	6,080	49.84	G5SW	Chelmsford, England	12,500	24				
W2XCC	L. Bamberger, Newark, N. J.	11,840	25.84	PJZ	Curaçao, Curaçao	9,500	31.6				
W2XCE	Atlantic Broadcasting Co., Jamaica, N. Y.	11,840	19.63	PJZ	Hamilton, Bermuda	11,820	19.71				
W2XCE	Atlantic Broadcasting Co., Jamaica, N. Y.	6,100	49.18	PCJ	Hilversum, Holland	9,560	31.38				
W3XAL	Radio Corporation, New York, N. Y.	9,570	31.35	PCJ	Hilversum, Holland	11,773	19.88				
W3XAL	Radio Corporation, New York, N. Y.	11,810	19.71	PHZ	Haarlem, Holland	11,773	19.88				
W3XAL	Radio Corporation, New York, N. Y.	15,130	19.83	OCX	Copenhagen, Denmark	6,090	49.26				
W3XAL	Radio Corporation, New York, N. Y.	17,780	16.87	OCX	Copenhagen, Denmark	9,560	31.38				
W3XAL	Radio Corporation, New York, N. Y.	21,500	13.95	Koenigswusterhausen, Germany	15,200	25.60					
W3XAL	Radio Corporation, New York, N. Y.	6,020	49.83	Koenigswusterhausen, Germany	22,000	13.95					
W3XAL	Radio Corporation, New York, N. Y.	6,060	49.5	Koenigswusterhausen, Germany	9,510	31.55					
W3XAU	Universal Broadcasting Co., Philadelphia, Pa.	9,580	31.3	VK3ME	Melbourne, Australia	6,122	19.92				
W6XAL	Pacific-Western Broadcasting Fed., Westminister, Calif.	6,080	49.84	WK6WF	Perth, Australia	11,810	25.40				
W6XAL	Pacific-Western Broadcasting Fed., Westminister, Calif.	15,250	19.67	WBX	Rome, Italy	10,770	27.86				
W6XAL	Pacific-Western Broadcasting Fed., Westminister, Calif.	21,500	13.95	WBX	Vienna, Austria	8,120	25.42				
W6XN	General Electric, Oakland, Calif.	12,850	23.35	VK2ME	Sidney, Australia	6,072	49.4				
W6XN	Crosley Radio Corporation, Cincinnati, Ohio	6,060	49.8	UO2	Vienna, Austria	11,720	25.60				
W8XK	Westinghouse, East Pittsburgh, Pa.	9,570	31.35	CRX	Winnipeg, Canada	7,400	40.5				
W8XK	Westinghouse, East Pittsburgh, Pa.	11,880	25.25	ZID	Durban						
W8XK	Westinghouse, East Pittsburgh, Pa.	15,210	19.82								

[illegible][illegible]

Call	Meters	Call	Meters	Call	Meters
CM6HS Sagna la Grande.....	200				
CM6KP Sancti Spiritus.....	280				
CM6MN Santa Clara.....	200				
CM6HS Santa Clara.....	200				
CM6WT Santiago.....	200				
CM8BY Santiago.....	150				
CM8KW Santiago.....	250				
CM8KW Tinnucu.....	368				
	CURACAO				
OKR Bratislava.....	270	6CK Cork.....	225		
OKB Bratislava.....	342	2RN Dublin.....	413		
Kosice.....	293				
Moravska-Ostrava.....	263	1BO Bolzano.....	445.9		
Praha.....	187	1GE Genoa.....	385.1		
Prague.....	250	1MI Milan.....	500.8		
	DANZIG	1NA Naples.....	331.4		
Danzig.....	453	1RO Palermo.....	209.8		
	DENMARK	1TO Rome.....	411.1		
Kalundborg.....	1153.8	Trieste.....	275.2		
Kalundborg.....	1680		256.4		
Kobenhavn.....	281				
Soro.....	1153.8				
Soro.....	1680				
	DOMINICAN REPUBLIC				
	DUTCH EAST INDIES				
PTC Batavia.....	220.7				
PLE Bandoeung.....	31.86				
PLE Bandoeung.....	15.93				
PLF Bandoeung.....	310				
Surabaya.....	140				
	ECUADOR				
SRE Cairo.....	255				
	EGYPT				
Tallinn.....	295				
	FINLAND				
Helsinki.....	291				
Lahden.....	1800				
Pietarsaaren.....	246				
SCG Porin.....	218				
Tampereen.....	400				
Turun.....	256				
Tammerfors.....	453				
Turku.....	446				
Vipuri.....	291				
	FRANCE				
PTT Bordeaux.....	304				
Corse.....	237				
Grenoble.....	329				
Limoges.....	293				
Lille.....	265				
Lyons.....	468				
Marseilles.....	316				
Montpellier.....	286				
Nice.....	227				
Paris.....	1725				
Paris.....	1444				
Paris.....	247				
Reims.....	272				
Strasbourg.....	346				
Toulon.....	383				
Toulon.....	255				
	FRENCH COLONIES				
SDP Algiers.....	310				
SKR Constantine.....	42.8				
TUA Haiphong.....	320				
Tunis.....	1450				
	GERMANY				
Aachen.....	453				
Augsburg.....	560				
Berlin.....	418				
Berlin II.....	283				
Bremen.....	339				
Breslau.....	325				
Dresden.....	319				
Flensburg.....	218				
Frankfurt.....	390				
Freiburg.....	42M				
Gleiwitz.....	253				
Hamburg.....	372				
Hannover.....	560				
Kaiserslautern.....	170				
Kassel.....	246				
Kiel.....	246				
Koln.....	227				
Konigsberg.....	276				
Konigsruherhausen.....	1635				
Langenberg.....	473				
Leipzig.....	259				
Magdeburg.....	283				
Munich.....	538				
Munster.....	234				
Nurnberg.....	239				
Stettin.....	283				
Stuttgart.....	360				
Zeessen.....	1635				
	GREAT BRITAIN				
2BD Aberdeen.....	301				
2BE Belfast.....	242				
6BM Bournemouth.....	288.5				
2LS Bradford.....	288.5				
2YT Cardiff.....	288.5				
5GB D					
5XX D					
5DE D					
2EH Edinburgh.....	288.5				
5HC Glasgow.....	399				
6KH Hull.....	500				
2LS Leeds-Bradford.....	288.5				
6LV Liverpool.....	288.5				
2LO London.....	377				
2ZY Manchester.....	261				
5NO Newcastle.....	288.5				
5PY Plymouth.....	288.5				
6WQ Swansea.....	288.5				
6ST Stoke-on-Trent.....	288.5				
6SX Swansea.....	288.5				
	GREECE				
	GUATEMALA				
	HAITI				
HHK Port au Prince.....	361.2				
	HEDJAZ				
	HOLLAND				
Bloemendaal.....	200				
Hilversum.....	1875				
Hilversum.....	1071				
Hilversum.....	298				
Hilzen.....	298				
Hilzen.....	1875				
Hilzen.....	1870				
Hilzen.....	1870				
	HUNGARY				
Lakihegy.....	550				
	ICELAND				
Akureyri.....	192				
Reykjavik.....					
	IRAQ				
	IRISH FREE STATE				
Cork.....	225				
Dublin.....	413				
	ITALY				
Bolzano.....	445.9				
Genoa.....	385.1				
Milan.....	500.8				
Naples.....	331.4				
Palermo.....	209.8				
Rome.....	411.1				
Torino.....	275.2				
Trieste.....	256.4				
	ITALIAN COLONIES				
	JAPAN				
Dairen.....	395				
Hiroshima.....	353				
Keijo.....	366				
Kumamoto.....	380				
Nagoya.....	370				
Osaka.....	400				
Sapporo.....	361				
Sendai.....	390				
Tokyo.....	345				
	JUGOSLAVIA				
Belgrade.....	429				
Ljubljano.....	506				
Zagreb.....	308				
	LATVIA				
Riga.....	525				
	LIBERIA				
	LITHUANIA				
Kaunas.....	1935				
	LUXEMBURG				
	MEXICO				
Chihuahua.....	325				
Guadalajara.....	250				
Jalapa.....	475				
Lerdo.....	250				
Merida.....	548.6				
Mexico City.....	325				
Mexico City.....	357				
Mexico City.....	410				
Mexico City.....	459				
Mexico City.....	470				
Mexico City.....	507				
Mexico City.....	600-500				
Monterrey.....	311				
Morelia.....	300				
Oaxaca.....	265				
Puebla.....	312				
	MONACO				
Monaco.....	237				
	MOROCCO				
Casablanca.....	250				
Casablanca.....	51				
Rabat.....	418				
Rabat.....	724.6				
	NEWFOUNDLAND				
	NEW HEBRIDES				
	NEW ZEALAND				
Auckland.....	275.2				
Auckland.....	232.1				
Auckland.....	333.3				
Christchurch.....	350				
Christchurch.....	306.1				
Dunedin.....	277.8				
Dunedin.....	277.8				
Dunedin.....	277.8				
Dunedin.....	461.5				
Dunedin.....	260.9				
Gisborne.....	285.7				
Palmerston.....	500				
Wanganui.....	416.7				
Wellington.....					
	NICARAGUA				
	NORWAY				
Alesund.....	453				
Bergen.....	364				
Fredrikstad.....	394				
Hamar.....	579				
Notodden.....	338				
Oslo.....	493				
Porsgrund.....	447				
Rjukan.....	453				
Tromso.....	1072				
Trondheim.....					
	PANAMA				
	PARAGUAY				
	PERSIA				
	PERU				
Lima.....	350				
	PHILIPPINE ISLANDS				
Manila.....	260				
Manila.....	270.3				
Manila.....	413				
	POLAND				
Krakow.....	313				
Krakow.....	244				
Kattowitz.....	408				
Lodz.....	234				
Poznan.....	335				
Warszawa.....	214				
Warszawa.....	1411				
Wilno.....	385.1				
	PORTUGAL				
Lisbon.....	305				
	PORTUGUESE COLONIES				
	ROUMANIA				
Bucharest.....	394				
Bucharest.....	226				
Jassy.....	211				
	SAAR TERRITORY				
	SALVADOR				
Salvador.....	452				
	SIAM				
	SPAIN				
Almeria.....	251				
Barcelona.....	462				
Barcelona.....	344.8				
Barcelona.....	434.8				
Bilbao.....	400				
Cadiz.....	400				
Cartagena.....	216				
Las Palmas.....	250				
Las Palmas.....	350				
Madrid.....	375				
Madrid.....	234				
Malaga.....	100				
Oviedo.....	268				
Salamanca.....	453				
San Sebastian.....	349				
Seville.....	368				
	SURINAM				
	SWEDEN				
Boden.....	1200				
Borna.....	231				
Eskestuna.....	246				
Falun.....	322				
Gavle.....	322				
Goteborg.....	216				
Halmstad.....	231				
Helsingborg.....	257				
Horby.....	270				
Hudiksvall.....	202				
Kalmar.....	202				
Karlshamn.....	196				
Karlstad.....	218				
Kiruna.....	246				
Kristinehamn.....	203				
Malmberget.....	436				
Malmo.....	231				
Motala.....	1348				
Norrkoping.....	270				
Orebro.....	218				
Ornskoldsvik.....	770				
Ostersund.....	246				
Safo.....	436				
Stockholm.....	270				
Sundsvall.....	542				
Sundsvall.....	270				
Trollhattan.....	283				
Umea.....	281				
Uppsala.....	453				
Varberg.....	283				
	SWITZERLAND				
Bale.....	1010				
Berne.....	403				
Geneva.....	780				
Lausanne.....	650				
Zurich.....	459				
	TURKEY				
Angora.....	1806				
Atatürk.....	1200				
Osmanieh.....	1200				
	UNION OF SOVIET SOCIALIST REPUBLICS				
Archangel.....	511				
Arnavir.....	720				
Artimorsk.....	379				
Astrakhan.....	700				
Baku.....	750				
Bogorodsk.....	750				
Dnepropetrovsk.....	383				
Erivan.....	1050				
Gomel.....	433				
Irkutsk.....	1100				
Ivanovo-Vosnesensk.....	337				
Khar'kov.....	1364				
Kiev.....	1304				
Koumsk.....	401				
Krasnodar.....	513				
Khar'kov.....	427				
Leningrad.....	351				
Leningrad.....	1000				
Minsk.....	700				
Moscow.....	938				
Moscow.....	825				
Moscow.....	497				
Moscow.....	450				





AIR-LINE DISTANCES IN STATUTE MILES

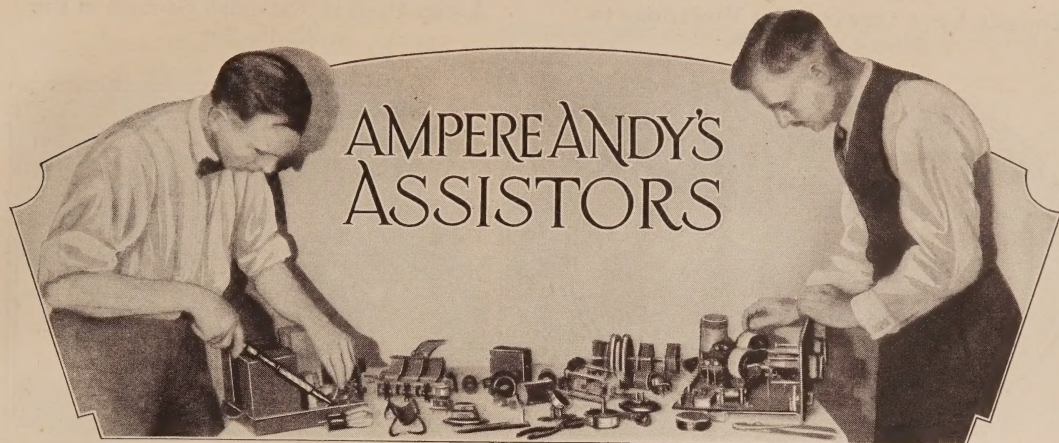
FROM/TO	Albuquerque, N. Mex.	Atlanta, Ga.	Baltimore, Md.	Boise, Idaho	Boston, Mass.	Brownsville, Tex.	Buffalo, N. Y.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Denver, Colo.	Des Moines, Iowa	Detroit, Mich.	El Paso, Tex.	Fargo, N. Dak.	Fort Worth, Tex.	Galveston, Tex.	Hastings, Nebr.	Hot Springs, Ark.	Houghton, Mich.	Jacksonville, Fla.	Kansas City, Mo.	Los Angeles, Calif.	Louisville, Ky.	Memphis, Tenn.
Albuquerque, N. Mex.	1273	1273	1670	774	1967	838	1577	1126	1248	1417	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938
Atlanta, Ga.	1273	575	1830	933	1967	838	1577	1126	1248	1417	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938
Baltimore, Md.	1670	575	1830	933	1967	838	1577	1126	1248	1417	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938
Boise, Idaho	774	1830	2055	2556	2266	1881	1575	1234	1184	1402	1047	1102	1398	682	1445	471	287	1013	650	1543	1025	923	1030	1093	777
Boston, Mass.	1967	2055	2556	2266	2266	1881	1575	1234	1184	1402	1047	1102	1398	682	1445	471	287	1013	650	1543	1025	923	1030	1093	777
Brownsville, Tex.	838	960	1525	1610	1981	1575	1575	1234	1184	1402	1047	1102	1398	682	1445	471	287	1013	650	1543	1025	923	1030	1093	777
Buffalo, N. Y.	1126	1126	1234	1184	1402	1047	1102	1398	682	1445	471	287	1013	650	1543	1025	923	1030	1093	777	1025	923	1030	1093	777
Chicago, Ill.	1248	1248	1398	682	1445	471	287	1013	650	1543	1025	923	1030	1093	777	1025	923	1030	1093	777	1025	923	1030	1093	777
Cincinnati, Ohio	1417	1417	1543	860	1543	471	287	1013	650	1543	1025	923	1030	1093	777	1025	923	1030	1093	777	1025	923	1030	1093	777
Cleveland, Ohio	332	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588
Denver, Colo.	833	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938	561	803	588	773	1252	1492	717	663	1174	938
Des Moines, Iowa	1360	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938	561	803	588	773	1252	1492	717	663	1174	938	588
Detroit, Mich.	228	228	968	561	803	588	773	1252	1492	717	663	1174	938	561	803	588	773	1252	1492	717	663	1174	938	588	773
El Paso, Tex.	968	968	561	803	588	773	1252	1492	717	663	1174	938	561	803	588	773	1252	1492	717	663	1174	938	588	773	1252
Fargo, N. Dak.	561	561	803	588	773	1252	1492	717	663	1174	938	561	803	588	773	1252	1492	717	663	1174	938	588	773	1252	1492
Fort Worth, Tex.	803	803	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174
Galveston, Tex.	588	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938
Hastings, Nebr.	773	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588
Hot Springs, Ark.	1252	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773
Houghton, Mich.	717	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492	717	663	1174	938	588	773	1252	1492
Jacksonville, Fla.	1492	286	682	2098	1015	1025	880	861	623	768	1468	1024	832	1481	1400	943	799	1178	728	1216	943	460	1212	751	448
Kansas City, Mo.	717	675	962	1158	1250	923	862	413	541	700	555	180	643	836	548	460	467	226	326	633	799	777	1423	480	370
Los Angeles, Calif.	663	1925	2313	663	2590	1370	2195	1741	1892	2044	828	1433	1976	702	1426	1212	1423	1177	1437	1787	952	1352	1825	1602	319
Louisville, Ky.	1174	317	498	1623	823	1093	483	268	92	309	1035	47	621	1253	818	751	807	693	480	636	595	480	1825	319	319
Memphis, Tenn.	938	335	922	1506	1133	777	802	481	410	627	878	485	621	978	882	1093	327	513	666	901	1216	952	2153	595	591
Miami, Fla.	1710	610	958	2368	1258	1100	1184	1190	957	1088	1732	1338	1156	1662	1721	1150	941	1468	983	1545	328	1247	2355	923	878
Minneapolis, Minn.	980	905	948	1140	1125	1335	733	356	603	632	699	233	542	1156	219	870	1087	399	722	272	1192	413	1522	605	700
Missoula, Mont.	895	1790	1947	252	2124	1706	1740	1348	1578	1640	670	1074	1552	1115	819	1312	1595	891	385	1208	2070	1117	910	1550	1483
Nashville, Tenn.	1117	218	597	1631	941	952	626	394	239	456	1018	523	468	1169	900	643	666	697	370	760	502	472	1777	153	195
New Orleans, La.	1030	427	1001	1713	1359	536	1087	831	708	922	1079	825	938	986	1221	470	288	870	358	1187	511	678	1675	623	358
New York, N. Y.	1810	747	170	2153	188	1695	291	711	568	404	1628	1023	843	1902	1213	1398	1415	1275	1125	849	838	1097	2446	665	953
Norfolk, Va.	1696	507	167	2137	467	1465	435	696	474	429	1562	983	522	1755	1258	1226	1195	1216	955	946	946	1009	2352	528	778
Oklahoma, Okla.	518	753	1113	1138	1490	659	1113	689	755	946	1562	983	522	1755	1258	1226	1195	1216	955	946	946	1009	2352	528	778
Omaha, Nebr.	718	815	1026	1044	1280	1061	883	432	620	738	485	122	666	875	390	188	456	357	260	926	988	293	1182	675	422
Philadelphia, Pa.	1748	663	90	2113	268	1614	278	664	501	343	1575	972	442	1834	1186	1324	1335	1222	1051	827	758	1037	2388	580	878
Phoenix, Ariz.	330	1592	2002	733	2295	1023	1904	1451	1578	1745	585	1154	1685	347	1225	858	1065	901	1094	1550	1800	1045	357	1512	1264
Pittsburgh, Pa.	1498	520	194	1863	478	1424	178	411	258	115	1320	718	208	1592	952	1097	1140	1678	1454	1371	703	784	2135	345	660
Portland, Me.	2015	1022	446	2282	100	1961	438	892	802	603	1803	1197	657	2126	1313	1642	1678	1454	1371	924	1113	1300	2631	892	1205
Portland, Ore.	1107	2172	2367	349	2553	1944	2167	1765	1987	2063	985	1479	1975	1286	1248	1612	1885	1271	1733	1638	943	1397	825	1953	1852
Richmond, Va.	1628	470	128	2060	471	1428	375	618	399	353	1488	905	445	1695	1180	1170	1154	1142	897	870	758	1037	2388	580	878
St. Louis, Mo.	938	467	731	1389	1036	975	662	259	308	404	793	270	452	1033	658	568	697	455	325	591	755	238	1585	242	242
Salt Lake City, Utah	483	1580	1858	292	2099	1317	1701	1260	1450	1567	372	952	1490	689	865	977	1249	708	1116	1242	1840	922	577	1400	1250
San Francisco, Calif.	893	2133	2451	516	2696	1675	2298	1855	2037	2163	946	1547	2087	993	1447	1454	1693	1297	1648	1833	2375	1500	345	1983	1800
Schenectady, N. Y.	1823	840	278	2120	150	1770	249	702	605	408	1618	1012	467	1930	1111	1445	1487	1267	1175	776	960	1107	2445	695	1010
Seattle, Wash.	1178	2180	2341	405	2508	2015	2130	1743	1974	2035	1020	1470	1945	1373	1206	1658	1938	1288	1759	1588	2450	1505	956	1945	1867
Shreveport, La.	764	548	1064	1433	1410	510	1080	725	688	904	799	624	891	752	1002	209	233	615	142	1043	733	326	1420	598	279
Spokane, Wash.	1028	1960	2110	290	2279	1805	2090	1514	1746	1804	827	1243	1715	1238	976	1470	1753	1061	1552	1360	2239	1286	939	1720	1652
Springfield, Mass.	1889	863	282	2196	79	1850	325	774	659	473	1692	1085	540	1990	1240	1495	1524	1304	1224	860	957	1173	2515	745	1055
Vermillion, S. Dak.	742	917	1083	973	1314	1161	916	479	694	785	468	187	705	920	284	689	938	167	605	510	1				

AIR-LINE DISTANCES IN STATUTE MILES

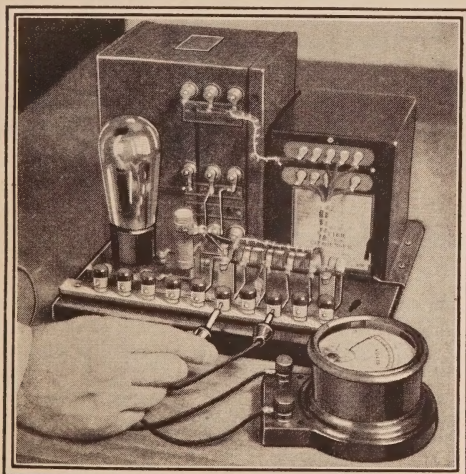
FROM/TO	Miami, Fla.	Minneapolis, Minn.	Missoula, Mont.	Nashville, Tenn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma, Okla.	Omaha, Nebr.	Philadelphia, Pa.	Phoenix, Ariz.	Pittsburgh, Pa.	Portland, Me.	Portland, Ore.	Richmond, Va.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Schenectady, N. Y.	Seattle, Wash.	Shreveport, La.	Spokane, Wash.	Springfield, Mass.	S. Dak.	Washington, D. C.
Albuquerque, N. Mex.	1710	980	895	1117	1030	1810	1696	518	718	1748	330	1498	2015	1107	1628	938	483	893	823	1178	764	1028	1889	742	1648
Atlanta, Ga.	610	948	1790	218	427	747	507	753	1026	663	1592	520	1022	2172	470	467	1580	2133	2480	2180	1064	1960	863	917	542
Baltimore, Md.	958	948	1947	597	1001	1740	167	1173	1016	663	2202	194	446	2172	128	470	1580	2133	2480	2180	1064	1960	863	917	542
Boise, Idaho	2368	1140	252	1631	1713	2137	1138	1044	1113	1748	330	1498	2015	1107	1628	938	483	893	823	1178	764	1028	1889	742	1648
Boston, Mass.	1258	1125	2124	941	1359	1888	467	1490	1280	268	2295	478	101	2553	471	1039	2099	2696	150	2508	1410	2279	79	1314	392
Brownsville, Tex.	1100	1335	1706	952	536	1695	1465	659	1061	1614	1023	1424	1961	1944	1428	975	1317	1675	1770	2015	510	1852	1805	1161	1493
Buffalo, N. Y.	1184	733	1740	626	1087	291	435	1117	883	278	1904	178	438	2167	375	662	1701	2298	249	2130	780	1900	325	916	290
Chicago, Ill.	1190	356	1348	394	831	711	696	689	432	664	1451	411	892	1765	618	250	1260	1855	702	1743	1255	1514	774	479	594
Cincinnati, Ohio	957	603	1578	239	708	1408	474	755	620	501	1578	258	803	1967	399	308	1450	2037	605	1974	688	1746	659	694	403
Cleveland, Ohio	1088	632	1640	456	922	1602	429	746	738	343	2295	478	101	2553	471	1039	2099	2696	150	2508	1410	2279	79	1314	392
Denver, Colo.	1732	699	670	1018	1079	1628	1562	503	485	1575	585	1320	1803	985	1488	793	372	946	1618	1020	799	827	1692	468	1490
Des Moines, Iowa	1338	235	1074	523	825	1023	823	469	122	972	1154	718	1197	1470	905	702	952	1547	1012	1470	624	1243	1085	187	895
Detroit, Mich.	1156	542	1552	468	938	483	522	905	666	444	1635	208	657	1975	445	452	1490	2087	467	1945	891	1715	540	705	397
El Paso, Tex.	1662	1156	1115	1169	966	1902	1735	875	1834	1367	1392	1392	2126	1286	1695	1033	689	993	1930	1373	752	1238	1990	920	1726
Fargo, N. Dak.	1721	219	819	900	1221	1213	1258	786	390	1186	1225	952	1313	1248	1180	1638	865	943	1447	1157	1002	976	1224	284	1141
Fort Worth, Tex.	1150	870	1312	643	470	1398	1226	188	590	1324	858	1147	1642	1612	1170	568	977	1454	1445	1658	209	1470	1495	689	1210
Galveston, Tex.	941	1087	1595	666	288	1415	1195	456	828	1335	1065	1140	1678	1885	1154	697	1249	1693	1487	1938	233	1753	1524	938	1214
Hastings, Nebr.	1468	399	891	697	870	1275	1216	357	135	1222	1091	967	1454	1271	1142	455	708	1297	1267	1759	615	1061	1340	167	1139
Hot Springs, Ark.	983	722	1385	370	358	1125	955	260	490	1051	1094	825	1371	1733	897	325	1116	1648	1175	1759	142	1552	1224	605	936
Houghton, Mich.	1545	272	1208	760	1187	849	946	926	547	827	1550	630	924	1638	870	591	1242	1833	776	1588	1043	1360	860	510	813
Jacksonville, Fla.	328	1192	2070	502	511	1638	548	988	1098	758	1800	703	1113	2442	953	755	1840	2375	960	2450	323	2239	957	1203	647
Kansas City, Mo.	1247	413	1117	472	678	1097	1009	293	165	1037	1800	703	1113	2442	953	755	1840	2375	960	2450	323	2239	957	1203	647
Los Angeles, Calif.	2355	1522	910	1777	1675	2446	2352	1182	1312	588	357	2135	361	825	2283	1585	577	345	2445	956	1420	939	2515	1291	2295
Louisville, Ky.	923	605	1550	153	623	650	528	615	579	580	1512	345	892	1953	457	242	1400	1983	695	1945	598	1720	745	663	473
Memphis, Tenn.	878	700	1483	195	358	953	778	422	529	878	1264	660	1205	1852	722	242	1250	1800	1010	1867	279	1652	1055	642	763
Miami, Fla.	1516	916	2359	821	681	1095	802	1233	1402	1023	1968	1014	1357	2716	831	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Minneapolis, Minn.	1516	916	2359	821	681	1095	802	1233	1402	1023	1968	1014	1357	2716	831	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Missoula, Mont.	2359	1010	1010	695	1030	1019	1047	692	291	985	1279	745	1145	1435	968	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Nashville, Tenn.	821	695	1582	470	758	758	586	602	604	683	1445	472	1015	1970	526	253	1390	1958	820	1973	470	1752	863	704	567
New Orleans, La.	881	1050	1733	470	1173	1173	932	575	845	1090	1318	923	1454	2063	899	599	1433	1259	2098	2820	290	1898	1287	960	968
New York, N. Y.	1095	1019	2030	758	1173	293	324	1144	83	2142	1968	1014	1357	2716	831	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Norfolk, Va.	802	1047	2045	586	932	293	316	1186	1095	250	2027	316	565	2458	70	771	1925	2510	426	2440	1037	2211	411	1166	145
Oklahoma, Okla.	1233	692	1162	602	575	1224	1186	405	405	1256	843	1013	1550	1488	1122	456	862	1384	1354	1373	297	1324	1412	502	1150
Omaha, Nebr.	1402	291	978	604	845	1144	1095	405	405	1094	1032	837	1318	1373	1020	352	833	1425	1133	1372	617	1149	1205	115	1012
Philadelphia, Pa.	1023	985	1997	683	1090	83	220	1256	1094	1094	2079	254	360	2419	205	808	1923	2518	2388	1153	2159	201	1143	122	122
Phoenix, Ariz.	1998	1279	932	1445	1318	1142	2027	843	1032	2079	1829	254	360	2419	205	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Pittsburgh, Pa.	1014	745	1754	472	923	313	316	1013	837	254	2345	545	545	2563	2381	1094	2127	2725	197	2513	939	1918	400	891	188
Portland, Me.	1357	1145	2133	1015	1445	277	565	1550	1318	360	1829	545	545	2563	2381	1094	2127	2725	197	2513	939	1918	400	891	188
Portland, Ore.	2716	1435	430	1970	2063	2455	2458	1488	1373	2419	1007	1714	2563	2381	2381	1723	636	536	2405	143	1783	295	2488	1293	2360
Richmond, Va.	831	968	1967	526	899	287	79	1122	1020	205	1960	242	565	2381	2381	699	1850	2436	406	2362	466	2362	406	2362	406
St. Louis, Mo.	1067	464	1331	253	599	873	771	456	352	808	1270	561	1094	1723	699	1158	1738	898	1722	1722	466	1500	958	450	710
Salt Lake City, Utah	2098	988	435	1390	1433	1972	1925	836	833	1923	504	1670	2127	636	1850	1158	1738	898	1722	1722	466	1500	958	450	710
San Francisco, Calif.	2603	1585	762	1958	1923	2368	1585	1386	1425	2518	652	2264	2725	536	2436	1738	898	1722	1722	466	1500	958	450	710	710
Schenectady, N. Y.	1229	975	1978	820	1259	142	426	1354	1133	205	1112	350	197	2405	406	989	1950	2548	2363	1290	2139	86	1165	313	313
Seattle, Wash.	2740	1403	395	1973	2098	2419	2440	1523	1372	2388	1112	2145	2513	143	2362	697	697	697	697	697	1820	229	2445	1282	2335
Shreveport, La.	950	859	1457	470	280	1230	1037	297	617	1153	1067	939	1484	1783	985	466	1155	1655	1290	1820	1621	1333	726	1035	1035
Spokane, Wash.	2528	1173	170	1752	1898	1190	2211	1324	1149	2159	2020	1918	2385	295	2133	958	548	730	2139	229	1621	2216	2216	1055	2105
Springfield, Mass.	2210	1056	2060	863	1287	120	411	1412	1205	201	2220	400	159	2488	407	958	2027	2625	86	2445	1333	2216	2216	1055	2105
Vermillion, S. Dak.	1510	238	887	704	960	1189	1166	502	115	1143	1980	891	1345	1293	1089	450	785	1383	1165	1282	1035	2105	2216	1055	2105
Washington, D. C.	927	936	1940	567	204	204	145	1150	1112	122	1980	188	480	2360	96	710	1845	2437	313	2335	1035	2105	2216	1055	2105

—Compiled by Department of Commerce.

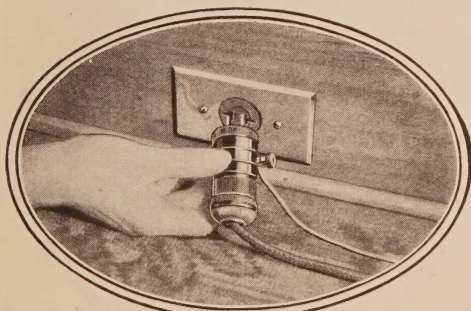
KC	Meters	STATIONS	DIALS		KC	Meters	STATIONS	DIALS	
			1	2				1	2
1500	199.9				1020	293.9			
1490	201.2				1010	296.9			
1480	202.6				1000	299.8			
1470	204.0				990	302.8			
1460	205.4				980	305.9			
1450	206.8				970	309.1			
1440	208.2				960	312.3			
1430	209.7				950	315.6			
1420	211.1				940	319.0			
1410	212.6				930	322.4			
1400	214.2				920	325.9			
1390	215.7				910	329.5			
1380	217.3				900	333.1			
1370	218.8				890	336.9			
1360	220.4				880	340.7			
1350	222.1				870	344.6			
1340	223.7				860	348.6			
1330	225.4				850	352.7			
1320	227.1				840	356.9			
1310	228.9				830	361.2			
1300	230.6				820	365.6			
1290	232.4				810	370.2			
1280	234.2				800	374.8			
1270	236.1				790	379.5			
1260	238.0				780	384.4			
1250	239.9				770	389.4			
1240	241.8				760	394.5			
1230	243.8				750	399.8			
1220	245.8				740	405.2			
1210	247.8				730	410.7			
1200	249.9				720	416.4			
1190	252.0				710	422.3			
1180	254.1				700	428.3			
1170	256.3				690	434.5			
1160	258.5				680	440.9			
1150	260.7				670	447.5			
1140	263.0				660	454.3			
1130	265.3				650	461.3			
1120	267.7				640	468.5			
1110	270.1				630	475.9			
1100	272.6				620	483.6			
1090	275.1				610	491.5			
1080	277.6				600	499.7			
1070	280.2				590	508.2			
1060	282.8				580	516.9			
1050	285.5				570	526.0			
1040	288.3				560	535.4			
1030	291.1				550	545.1			



Measuring High Voltage with Small Scale Meter



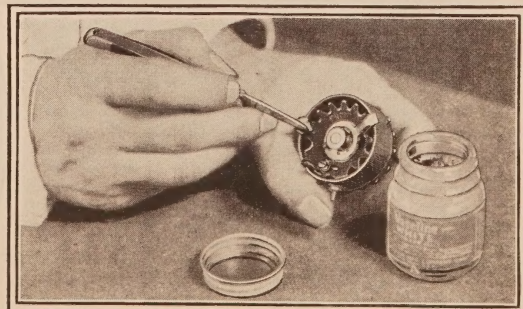
Readings of d. c. voltages several times the scale of the meter may be read on a power supply using a bleeder system. In the picture a half wave 281 rectifier is shown whose maximum voltage output would be around 425 volts. To read this with a 0-150 voltmeter, add values of negative to 90 volts, 90 to 180 volts and 180 to maximum voltages. The sum will be the overall voltage of the power supply which, however, should be measured under load in order to get accurate voltages.



A. C. line noises, clicking of household switches and other line interference may sometimes be eliminated from the alternating current sets by plugging the set's supply plug into a filter and then plugging the filter into the wall socket. The binding post at the side of the filter should be grounded.

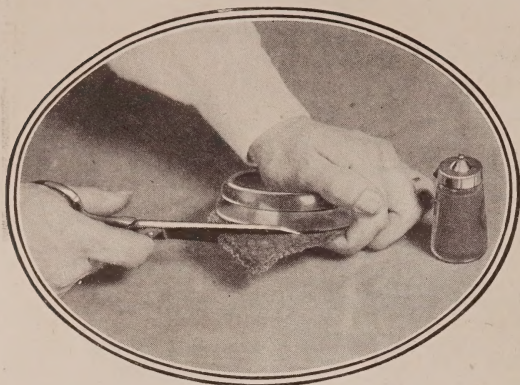
Novel Multiplier Permits Reading of Amperes with Milliammeter

A discarded tube socket can be made into a multiplier for reading amperes by means of a milliammeter. Between the binding post marked "loop" is placed a loop of enameled wire approximately No. 20 and about 5 inches long at the start, the length of the shunt being found by comparison of an ampere meter against a milliammeter. The ampere meter is in series with the shunt while the milliammeter is across the shunt. Then when the ammeter reads 5 amperes the shunt may be lengthened until the milliammeter reads 5 mils. The milliammeter is placed across the two binding posts in the front of the photograph, each of these posts being connected to a loop post by means of a solder lug. The shunt is placed between the two loop posts. In the beginning of calibration the shunt wire should not be more than about 5 inches in length to prevent burning out the milliammeter. The socket is equipped with an aluminum base. More than one shunt may be made of different values and the shunt ratio written on the base of the socket.

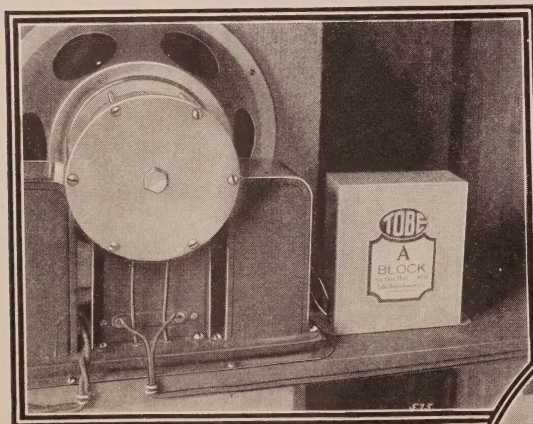


Many times the operation of a volume control will result in set noises due to an imperfect contact. This trouble may be eliminated by wiping the wire surface clean with a dry rag and then putting on the wire surface a small film of white unmedicated vaseline or Nujol. This oily film will prevent corrosion. Be sure the movable arm is making good contact at the beginning.

Console Legs Transmit Set Vibrations to Floors and Walls

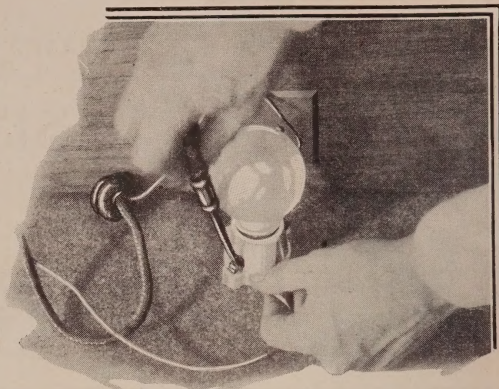


If the "boom boom" of an orchestra coming through a radio set in the apartment above you is extremely noticeable, you may be assured the console legs of the installation up-stairs are probably resting directly on the wooden floor and are transmitting sound vibrations through the floor and walls. This is particularly noticeable on the lower frequencies. A simple cure is to place the radio set on a rug or carpet. If that is not feasible take four glass cups of the kind shown in the photograph, glue a piece of ozite to the bottom of each cup and then set the cups under the four legs of the console. The ozite on the bottom of the cup will prevent the passage of mechanical vibrations from the radio set. You might do this yourself and tell your neighbor about it, too



Above is shown a method of placing a filter condenser across the rectifier output on a dynamic speaker utilizing 6 volt contact rectifiers. Part of the hum found in the older type dynamic speakers was produced by imperfect filtration of the rectifier. A filter block such as the one shown may be placed inside of the speaker cabinet and the two wires from the condenser placed across the extremities of the rectifier. There is no polarity to the condensers so it does not matter which connections go to the rectifier ends. A small condenser may not always suffice and for that reason one with 2000 or more microfarads will have to be used in obstinate cases

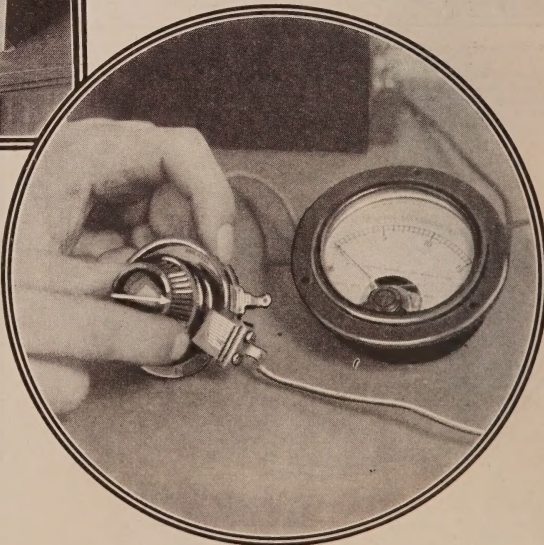
Lamp Used to Establish Ground in the Radio Set



A simple means of grounding your 110 volt supply at your radio set instead of the pole transformers out in the alley is shown in the photograph above, where a small electric light bulb, 15 watts, is connected to one side of your set supply plug, the other side going to a water pipe ground. When the plug is put into the wall receptacle in one direction the light will glow. The plug should then be turned around so that the light does not glow. Under these conditions the neutral wire is grounded directly to your water pipe and this may eliminate some of the hum that is found in radio sets where an extremely long neutral wire is employed. The lamp consumes no current. It is only used as a protective measure to show the user which is the live side of the line and which is the neutral

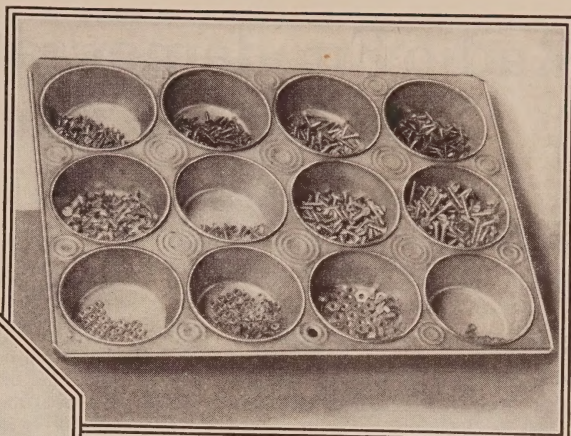
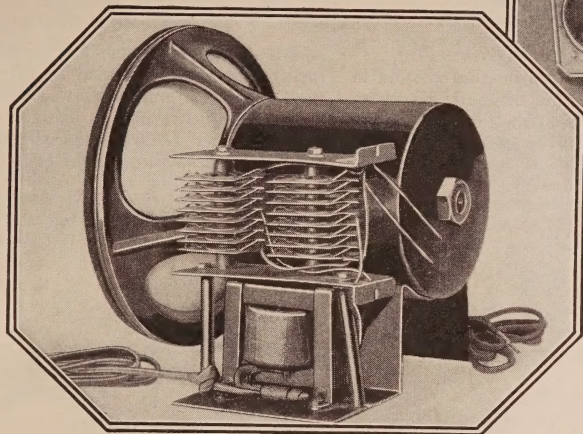
Rheostat Serves as a Variable Shunt for Milliammeter

In the picture below is shown an 0-15 milliammeter with a variable resistance in shunt. Many times the service man will want to read total current in a circuit but having only a small meter may not be able to do so. The way to accomplish this is to take about a 25 ohm rheostat, place it in shunt to the milliammeter and turn the rheostat until the meter reads $\frac{1}{2}$ or $\frac{1}{4}$ of the smallest load. Then when the milliammeter is placed in series with the maximum load the reading may be multiplied either by two or by four depending on which ratio the service man desires



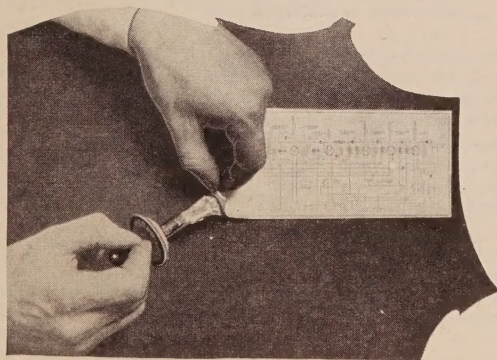
Now Your Wife Knows Where Her Muffin Tin Went

It is seldom that the radio hound can find any domestic utensils that will be of any service. However, there is one exception and that is the muffin tin shown at the right as a depository for assorted sizes of nuts, bolts and screws. By soldering a wire loop at the top left and right edges of the muffin tin it may be hung up against the wall. If you like muffins better than you like orderliness, you'd better drop in at the dime store and get a cheap muffin tin



At the left is shown a chassis of a dynamic speaker. At the bottom of the rectifier is located the step-down transformer used on a. c. jobs. Frequently the laminations in the transformer will be loose and their physical vibration is communicated to the cabinet of the speaker. In the event that there is no way of tightening up the laminations by means of a screw or clamp, the legs of the transformer may be raised from the bottom of the chassis and felt or blotter washers placed under these legs so as to absorb as much physical vibration as possible

Paste the Schematic of Your Set on Inside of Cabinet Cover



Here's a wail from the service man! "Please tell the public that when getting their set they should paste the schematic circuit on the inside of the cover or somewhere inside the cabinet so that when the service man comes along he can determine the electrical constants of the set without the owner having to rummage through the attic and three drawers in the writing desk to find this most important data." In the long run it is cheaper for the owner to have such information pasted inside the set because otherwise a service man takes two or three times as long to check for trouble. Since service man's time is by the hour the schematic of the set will enable him to get to work at once

Have a Spare Tube for Each Kind in Set



When buying a radio set it is always advisable to have one spare tube of each kind used in the receiver. These spares should be labeled and kept for test purpose only. Then when the owner has a suspicion one of the tubes is bad, he can plug in the spare to prove whether or not that tube is defective. The spares should only be kept for emergency purposes and a new tube should be bought as soon as a defective one is located. As a rule the spares would be a 227, a 226, and a 171 or 245. With the number of screen grid sets, however, it is possible that a 224 should also be listed among the spares

Radio Fundamentals Applied to Wires in Carrier Current Work

*Methods Employed Are Technically Important and Interesting;
Review of the Art Given*

By J. E. SMITH*

THE carrier method of multiplexing power lines, telephone and telegraph lines is technically one of the most interesting and important of the developments which have been perfected in the art of electrical communications during the past few years. In this article is given a brief sketch of the development of this art, an explanation of the principles on which it is based, and a description of a few of the applications.

How It Is Done

In a carrier multiplex system, a number of separate telephone, telegraph or signalling messages are superimposed simultaneously on a single electrical circuit by employing a separate alternating current, usually called a "carrier current," for each of the separate messages. This carrier current is made to vary in accordance with the variations of current representing the telephone, telegraph or signalling message. The different carrier frequencies which are superimposed on a circuit must differ sufficiently in frequency so that they may be separated from each other at the terminals by the use of proper electrical circuits. Each carrier may be of either audible or ultra-audible frequency, but its frequency must be higher than the highest frequency represented in the message to which it corresponds. These currents are known as carriers, since in a sense, they may be said to "carry" the telephone, telegraph or signalling cur-

rents by which they are controlled.

The underlying principles are old in the communication art and indeed go back to the date of the invention of the telephone itself, for it will be recalled that it was Bell's experiments with the

addition to the telephone and telegraph facilities normally afforded by the circuit. The telegraph systems in service are arranged to furnish as many as ten duplex carrier telegraph circuits over each circuit in addition to the telephone

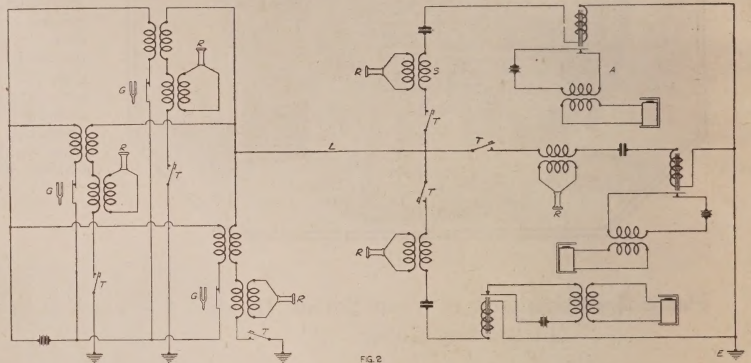


Fig. 2. Michael Pupin was another of the early inventors whose system is illustrated in simplified form

vibrating reed type of multiplex telegraph system which led to his discovery of the telephone. A short history of the art during the years that have elapsed between the conception of its possibilities by the early communication pioneers and the present realization of their hopes is given below under the heading "Historical."

In looking back over the early history of the carrier art it is now clear that the development of successful multiplex carrier systems had necessarily to await not only the evolution of the fundamental ideas for carrier operation, but also the development of radically new types of apparatus and the developments in electrical wave transmission over wires which have characterized the recent progress of long-distance telephony.

Circuits Used Daily

Some of the telephone and telegraph systems which are described are in daily use over long toll circuits in the Bell telephone system. The telephone installations in service furnish simultaneously as many as four two-way telephone conversations over each circuit in

and telegraph facilities normally afforded by the circuit. These figures do not indicate the maximum numbers of facilities which it will be found economical to employ ultimately, but cover the facilities furnished by the systems which are now commercially employed.

The increased circuit facilities obtained in this way are, in general, up to the high standards set for the best grade of long-distance circuits. They are relatively stable and are maintained by the regular telephone plant personnel. The carrier circuits, both telephone and telegraph, are so designed that as circuits they fit in completely with the more usual circuit facilities of the telephone system. They may be connected

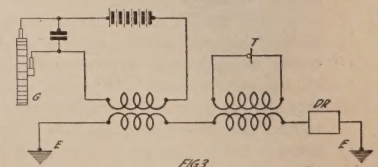


Fig. 3. Hutin and Leblanc illustrated the use of relatively high frequency alternating current for telephony in the above diagram

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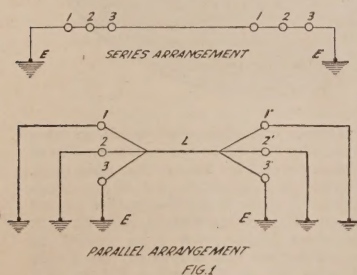


Fig. 1. The multiplex system illustrated here is a reproduction of Elisha Gray's system published in 1886

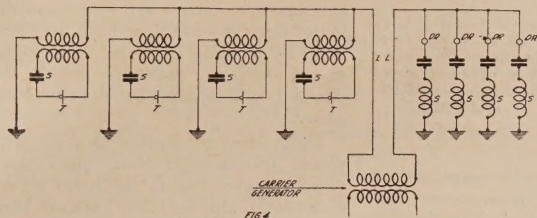


Fig. 4. Another diagram representative of early 1892 contributions to carrier telephony is reproduced at the left

with each other and with ordinary circuits, and, in general, present much the same degree of practicability and flexibility of operation as do the more usual forms of circuits.

While the development has thus succeeded in making available to the communication art new types of circuit facilities, these facilities can only be made to meet the high standards required in a public service plant by the use of correspondingly high-grade equipment which, unfortunately, is correspondingly expensive. Indeed, the cost of these systems, at least at present, is such as to make their use economical only over relatively long toll circuits. For short-distance toll service, and for local exchange service, the equivalent facilities can be provided more cheaply by the older methods.

Historical

As indicated above, the multiplex carrier art had its origin in the harmonic telegraph systems dating back to the time of the invention of the telephone itself. With such alternating-current telegraph systems are associated the names of Gray, Bell, Van Rysseberghe, Edison and Mercadier. The multiplex feature of these systems is well illustrated by Fig. 1, which is a reproduction of a diagram of Elisha Gray's system published in 1886.

In this figure, the circles numbered 1, 2 and 3 represent vibrating reed transmitting instruments, while those numbered 1', 2' and 3', represent the corresponding receiving electromagnetic reeds. When one of the transmitting reeds is vibrated, the electrical waves sent out set into oscillation the correspondingly tuned receiving reed which thus gives out an audible note. The systems invented by these pioneers are all characterized by the use of the mechanical resonance of tuned reed instruments for generating and selecting the carrier frequencies involved. This type

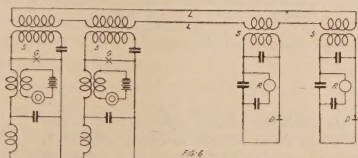


Fig. 6. The Ruhmer system in vogue in Europe around 1910 is illustrated in the above diagram

of system has been more fully developed by Mercadier.

The Art of the 1890's

Shortly after 1890 there occurred the next outstanding development in this art, namely, the use of electrical resonance instead of mechanical resonance for selecting the carrier frequencies. An interesting piece of technical history is disclosed in the manner in which several investigators, Professor Pupin, Hutin and Leblanc, and John Stone independently invented about the same time the electrical method of selection of a plurality of carrier frequencies. Pupin was adjudged the earliest inventor in the United States. His original system is illustrated in simplified form in Fig. 2.

In order to permit the successive figures in this historical discussion to be readily followed, a uniform system of lettering their important parts has been employed. These conventions are as follows:

- G—Generator of carrier current.
- T—Telegraph key, telephone transmitter or other carrier modulating device.
- L—Line.
- S—Selecting or tuned circuit.
- D—Detector.
- A—Amplifier.
- R—Receiver.
- DR—Detecting receiver.
- E—Earth.

By following this lettering Fig. 2 will be readily understood. It will be noted that at each end the line branches into three parts, and that each circuit is tuned by capacity and inductance to a particular frequency. It will be seen, furthermore, that each of the channels derived in this manner is arranged for sending in both directions, although not simultaneously. Each generator consists of a self-excited tuning fork driving a contact or a microphone transmitter. Receiving is accomplished either by a telephone receiver or by a vibrating reed device which is operated by a microphone amplifier.

Pupin also invented an electrolytic detector for use in such alternating-current telegraph systems.

The function of this detector was to rectify the alternating current and thus enable a d-c. telegraph relay to be operated from the rectified current.

This marked the beginning of the use of separate devices for performing the two primary functions of carrier receiving; (1) that of reproducing from the carrier the current variations which represent the original signals, and (2) that of indicating the signals, as by relay or telephone receiver. The separation of these two functions is important in the carrier art because it permits the place at which detection is effected to be separated from that at which the indication or interpretation occurs.

While the contributions up to this time were concerned primarily with telegraphy, they were very soon carried over into the field of telephony (still in the early 90's) by such pioneers as Gibboney, Hutin and Leblanc, and Stone. Their predecessors were concerned with the use of carrier frequencies of the order of a few hundred cycles, whereas, these inventors appreciated the necessity of employing for telephony carrier currents sufficiently high in frequency to preserve the characteristics of the voice currents. Thus we find suggested at this early date the use of carrier currents in the tens of thousands of cycles, which values have since proved to be in the

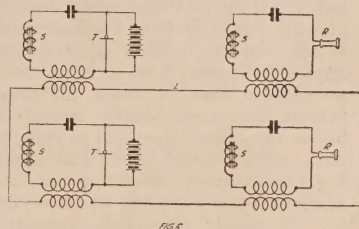


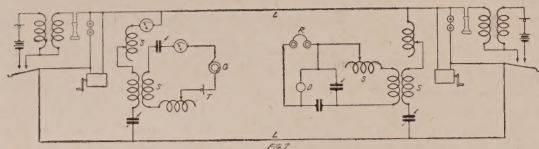
Fig. 5. The system developed by John Stone during 1894 is here illustrated

preferred frequency range. Hutin and Leblanc so simply illustrated the use of relatively high-frequency alternating currents for telephony that it is useful to reproduce their early diagram as shown in Figure 3, for the purpose of obtaining in our discussion an appreciation of the principles involved.

Simple Carrier System

This is a carrier telephone circuit of the simplest type, arranged for a single one-way transmission. Connected in the line are three elements, the generator of the high-frequency currents *G*, the voice-actuated modulator *T*, and the detector-receiver *DR*. The generator is a high-frequency commutator; the modulator is a microphone transmitter; and the receiver which is of the dynamometer type serves the double function of detection and of translation into sound waves.

Multiplex operation of this type of carrier telephone channel as devised by these French inventors at the same time (about 1892) is also representative of



these early contributions to carrier telephony and is reproduced in Fig. 4. Here we have the carrier telephone channel of Fig. 3, arranged for multiplex operation by the use of electrical selection, each of the carrier circuits being tuned by capacity and inductance to its own carrier frequency.

As indicated the carrier currents of all the channels are introduced into the line at a common point through a transformer. At each terminal the line divides into four branches. Each sending branch contains a microphone transmitter *T* connected into circuit through a transformer. Each receiving branch contains a dynamometer receiver *DR*. The condenser in each transmitting circuit and the inductance in each receiving circuit were employed in tuning the channels.

The multiplex system invented by John Stone was very similar to those illustrated above by Pupin, and Hutin and Leblanc, and is therefore not illustrated. It did, however, contain an important improvement over those of his contemporaries in that he tuned the local branch circuit individually instead of tuning the system from end to end for each carrier channel, as did Pupin, and Hutin and Leblanc. This improvement is evident also in a system which he developed shortly afterwards, especially for high-frequency transmission. This is illustrated in Fig. 5.

Stone devised and tested this system in 1894. The high-frequency currents were generated by means of small arcs which were fed from a d-c. source through a suitable choke coil. One of the electrodes of each arc in Fig. 5, was made light in weight and was attached to a diaphragm which served, when acted upon by voice air waves, to modulate the high-frequency currents generated by the arc. The particular arrangement illustrated is also of interest in showing the tuned circuits at both the sending and receiving ends as associated with the line in a series manner, an arrangement which is an alternative of the parallel connections previously illustrated.

It is also of interest to note in connection with these older multiplex telegraph systems that Van Rysselberghe recognized as early as 1886 the advantage of superimposing the alternating-current circuits on an ordinary d-c. telegraph circuit, thereby enabling the ordinary telegraph wires to be employed for the transmission of the multiplex system. While the idea of extending

the range of frequencies employed in the multiplex system down to zero frequency and thereby including the d-c. signaling circuit would naturally be obvious in a more advanced stage of the art, its invention at this early date illustrates the clear engineering appreciation these earlier inventors possessed.

It will be seen, therefore, that the foundation of the carrier art was laid back in the 1890's, at which time there had been contributed these cardinal features:

1. Electrical selection or tuning.
2. The use of continuously generated high-frequency carrier currents.
3. Modulation of the carrier, as by a microphone transmitter.
4. Detection and indication of the high-frequency currents by means responsive continuously and proportionally to the received current.

Relations of Radio Developments

With the entrance of wireless telegraphy into the communication field, the attention of those scientists and engineers who might otherwise have developed the art of wire multiplex, so well begun, as indicated above, seems to have been diverted to the newly found art. The wireless art started with the use of very high frequencies, generated discontinuously by the spark method, and gradually came to use waves of lower and lower frequency, and of increasing persistency. Finally, with the use of continuously generated waves, the radio-frequency range came to overlap the frequency range earlier employed in high-frequency wire transmission. The wire carrier art started with the use of audible frequencies and extended into the ultra-audible range, where it was later met by the radio frequencies. The similarity of the history of the two developments is illustrated by the fact that the major steps, which are noted above

for the early carrier art, also mark the major steps of advancement of the radio art. By reading over the four points above, keeping radio in mind, the parallel will be seen to be quite complete.

These ideas of continuous wave telephone transmission were quite thoroughly appreciated in the radio art by about 1905, although they have not been fully attained in practice until quite recently. It was natural that radio engineers should carry these ideas over to wires, using radio instrumentalities which, while different in form, operated on the same principles as did the means employed by the earlier wire pioneers.

Simultaneously with this evolution of the radio art, attention continued to be given to the older wire carrier transmission by such other investigators as Vreeland in America and Bela Gati and Maior in Europe. About 1906 Vreeland, using his well-known mercury-vapor oscillator as a generator of sinusoidal carrier currents, devised a multiplex carrier telegraph system which embodied improvements in the use of loosely coupled tuned circuits in proper relation to the impedance of the line. An engineering and commercial development of this period, as distinguished from more purely laboratory or theoretical investigations, was the so-called "Phantoplex" system devised by engineers of the Postal Telegraph Company and quite extensively employed by that company. In this system a relatively low-frequency carrier telegraph channel was superposed on the ordinary direct-current circuit. In addition to the above, attention may be called to the disclosures by Ehret and Kitsee. Ehret shows a multiplex carrier telephone system including amplifiers, and Kitsee shows a carrier telegraph channel operating over an ordinary telephone circuit.

Previous to 1910, Dr. Ruhmer in Europe had undertaken experiments on high-frequency wire transmission, employing apparatus taken from the then current radio art. Ruhmer's system is illustrated in Fig. 6.

He employed oscillating arcs as high-frequency generators, microphone transmitters as modulators, tuning at both

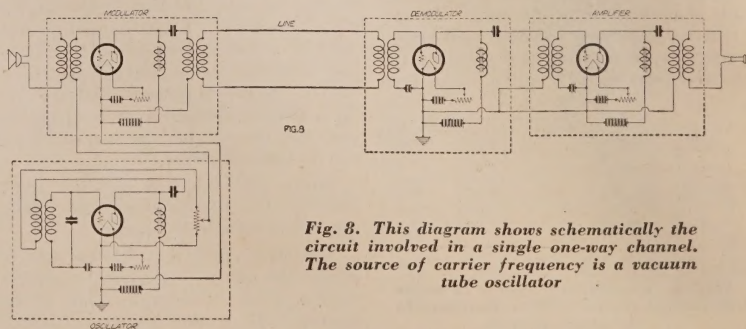


Fig. 8. This diagram shows schematically the circuit involved in a single one-way channel. The source of carrier frequency is a vacuum tube oscillator

the transmitting and receiving ends, and a radio detector in the receiving circuit.

In 1910 and 1911 Major, now Major-General, Squier carried out a set of experiments employing a carrier channel operating over a short telephone cable circuit. The announcement of his work popularized the interest in this art, and brought out considerable discussion.

The system which he used in his experiments is illustrated by Fig. 7. This figure shows a carrier telephone channel operating over the wires of an ordinary telephone circuit. A high-frequency alternator is employed to generate the carrier current, a microphone transmitter is used as a modulator, tuning is employed at the sending and receiving ends, and a radio detector is employed in the receiving circuit.

As a part of the evolution of the radio art, there was developed in its early and somewhat crude form a device which was destined to play an extremely important part, not only in radio, but in wire communication as well, that is, the thermionic tube. Originally invented by Edison, this device was first applied as a radio detector by Fleming about 1904. DeForest in 1906 made a vital contribution by adding the grid, and thereby laid the foundation for its use as an amplifier. The history of this very remarkable device is so well known that we will discuss it here only in connection with its specific application to the carrier art.

The preceding history brings us up to about 1912. About this time an important step was taken toward the adaption of the vacuum tube as a non-distorting amplifier by the addition of a negative grid battery by Lowenstein.

Since the above date, in addition to the active developments which were carried out in the Bell System and are described below, certain other investigators have been working in this field, among whom may be mentioned the General Electric Company, U. S. Signal Corp Engineers, Lee DeForest and certain European investigators, especially in Germany and France.

Bell System Developments

The most important developments, which have occurred since 1912 and are principally the work of the research and development departments of the Bell System, may be stated as follows:

1. Development of the thermionic vacuum tube into a reliable and stable instrument for amplification, modulation and demodulation.

2. Development of the electrical filter and an improved technique of separating electrical currents of different frequencies.

3. Development of the technique of transmission over wires, particularly in connection with repeater operation and

of methods for overcoming interference between circuits.

4. Development and operation of commercial carrier systems.

In considering the above developments which have led to commercial operation, it should be appreciated that in order for a carrier system to be commercially successful, it must compete on equal terms with the ordinary types of wire circuits, that is, it must have the same degree of reliability and stability, and must give the same degree of privacy and the same freedom from interference. Moreover, the system must be arranged so that it may be used interchangeably in the ordinary manner with any of the facilities furnished by the plant. All of these conditions must be met at a cost less than that of the ordinary types of circuits for similar service.

Vacuum Tube Developments

The development of the thermionic vacuum tube as an amplifying element in a telephone repeater has already been described as has also its application to radio telephony.

The success which attended these two lines of development indicated that in this one device was embodied the solutions of many of the controlling difficulties that had previously stood in the way of the commercial development of carrier systems. In connection with a resonant circuit, the vacuum tube provides a compact and reliable source of continuous oscillations of readily adjustable frequency. As an amplifier of both low and high-frequency currents, it removes the necessity for excessive line currents. As a modulator and demodulator, it provides an ideal means of impressing the voice waves on the carrier current, and of restoring them to their original form at the receiving end. These tubes have, moreover, been developed into devices which are very stable and reliable in operation, and may be maintained with only routine periodic supervision.

Electrical Filters

Another development which has been of vital importance in the success of carrier telephone systems is that of the "band-filter" invented by G. A. Campbell. Without such electrical filters, it would be impossible to utilize economically the relatively low-frequency range employed in the present carrier telephone systems, or to separate various channels in this range from each other or from the ordinary telephone and telegraph channels. The simple tuned circuits of the prior art would either introduce prohibitive distortion or, if made sufficiently non-selective to avoid distortion, would require placing the carrier channels widely apart in frequency. The Campbell filter, therefore,

enabled the carrier channels to be squeezed closely together at comparatively low frequencies where the difficulties of transmission over lines are at a minimum.

Wire Transmission Circuits

Since the attenuation over wire circuits is much greater at carrier frequencies than at the ordinary telephone frequencies the successful operation of carrier systems is particularly dependent on the use of repeaters at comparatively frequent intervals in the line. This has required the development of high-frequency repeaters. As in the case of telephone repeaters at voice frequencies, the amount of amplification which can be given by each repeater depends entirely on line conditions, such as the degree of line balance which can be maintained at the repeater point and the degree to which mutual interference between line circuits can be prevented.

This prevention of interference between line circuits required the development of more elaborate methods of transposing and adjusting them. In order to overcome the large transmission losses and irregularities introduced in open-wire lines by unavoidable sections of cable, new types of loading for cable circuits were developed for these carrier frequencies and put into practical use.

Commercial Carrier Systems

In 1914, simple forms of carrier circuits, embodying the fundamentals of our present system, were successfully set up in the laboratory, and experiments carried out with them. In view of the favorable conditions which had resulted from the various developments noted above, it was decided to begin active work toward commercial carrier systems. Field measuring apparatus was developed with which the characteristics of existing telephone lines were carefully studied in the carrier-frequency range. At the same time in the laboratory the physical possibilities and limitations of the various types of apparatus and circuits were being studied. Based on these fundamental data there was developed in the laboratory a complete multiplex telephone system providing two-way telephone conversations, and operating over an artificial line. This laboratory apparatus was then taken into the field and tried out on a line between South Bend, Indiana, and Toledo, Ohio. The practical difficulties always encountered were overcome, and satisfactory results were obtained on a simple type of carrier telegraph system between Chicago and Toledo.

The entry of this country into the war brought the work to a standstill for a time. However, the same cause

(Continued on page 97)

S-M 722 D. C. Now Designed for Use on Batteries With High Gain

When Using Standard Tube Combinations of Three 222's and Three 112-A's, Total Current Only 20 Mils.

FOR some time past there has been considerable of a demand on the part of individuals living in sections not served by alternating current lines for a receiver that will be economical as far as battery current is concerned and at the same time which will give performance on a par with the regular alternating current sets in other localities.

In considering the matter from the standpoint of economy it very early became apparent that it would be necessary to employ the screen grid battery tubes in order to cut down on the filament current and at the same time give the receiver the utmost in amplification possibilities that these screen grid tubes afford. Added to that there was the desirability of having a single tuning control for simplicity of operation.

Battery Supply

Inasmuch as the 722 a. c. receiver merchandised by the Silver-Marshall organization had been working quite satisfactorily it was thought that this particular design could readily be adapted to battery operation with a few minor changes in the chassis wiring to permit the use of storage batteries on the filament and "B" batteries for a plate supply.

By glancing at the schematic diagram shown in Figure 3 the reader will be able to get an idea of the type of circuit employed quite effectively in the 722 a. c. and now equally effective for battery operation. Looking at the input stage where a number 124 r. f. transformer is employed it will be seen that the primary of that transformer has two taps, one for use with a long antenna and the other for employment with a short one. Binding post No. 2 is for a short antenna, since it connects to the entire primary winding of the r. f. transformer. Binding post No. 1 is for a long antenna, since it taps in on the primary a number of turns down from the maximum inductance.

Uses Selector Coupler

The secondary of this inductance is led through a selector coupler No. 30X and then into the center tap of a 15-ohm center tap resistance in the negative side of the 222 filament. The secondary of this selector coupler is in series with the grid inductance r. f. coil No. 122

which also returns to the center tap of the 15-ohm resistor in the filament line. The r. f. transformer No. 124 is in a shielded can and the same applies to r. f. coil No. 122. One section of a .00035 mfd variable condenser goes between the cap of the first 222 tube and the ground.

From the plate of the first 222 tube the circuit is conventional through the r. f. transformer 123 primary and then to the plus 135-volt tap. The secondary is also of the conventional type, going

which serves to cut the voltage to the proper value for the operation of the 222 detector tube. The coupling from this stage to the input of the first audio tube where a 112-A is employed is by means of the .006 mfd fixed condenser leading into one terminal of a 2-A closed circuit jack. The other terminal of the jack leads to the grid of the 112-A and to one side of a 2 megohm resistance going to the minus C 4½-volt terminal. The frame of the jack is grounded and if desired a pick-up unit

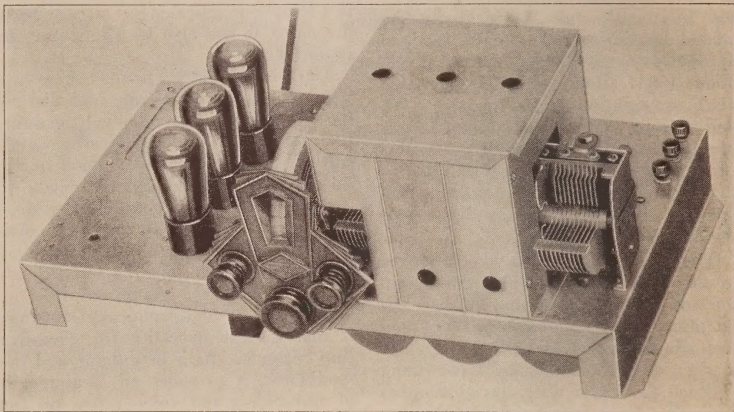


Fig. 1. Shown in this photograph is the S-M 722 battery operated receiver designed especially for individuals living in sections where alternating current is not available and who desire a receiver with high gain and current economy

from the cap of the second 222 to the center tap of a 15-ohm center tap resistance in series with the negative filament of the tube. The rotor on this condenser, of course, is common with ground. The second r. f. transformer, No. 123, is connected in the same fashion as the first one, although the secondary is connected to the grid circuit of the 222 detector through a .00015 mfd grid condenser spanned by a two megohm gridleak. The tuning capacity here is likewise between the G terminal of the inductance and ground.

Resistance Coupled

The plate circuit of the detector has a r. f. choke No. 275 which is bypassed by means of a .0005 mfd fixed condenser for the elimination of r. f. strays. Between one end of the r. f. choke and the plus 135-volt terminal there is a 60,000 ohm fixed resistance in series

may be plugged into this particular portion of the circuit.

The push-pull input transformer type 270-U is conventional and needs no particular explanation. The secondary feeds into each grid of the 112-A used in push-pull as a power output tube. The push-pull output is a choke, No. 258-S, the speaker being placed across the extremities of the choke and the center tap being supplied with 135 volts of B potential.

There is a 3-ohm sub-base rheostat used in the positive side of the A voltage supply as a means of securing proper voltage on the filaments of all tubes. The switch used on this receiver is an H-H 191 switch which breaks two lines, one being the minus A, B and plus C terminals and the other being that line carrying the 10,000 ohm potentiometer and the 20,000-ohm fixed resistance. Under these conditions when

Lincoln DeLuxe Ten Now Using Five Tuned Intermediate Stages

Screen Grid Tubes With Tunable Plate Inductances Employed to Get Maximum Amplification

ROUNDING out a year and a half of its experience in connection with the design of intermediate amplifiers the Lincoln Radio Corporation has now put out its DeLuxe Ten model which is described in the article to follow.

Photographically the chassis of the receiver may be seen in Figure 1 where a front and top view is given, while the schematic diagram of the receiver itself may be traced from the drawing in Figure 2. Figure 3 is a photograph of the power supply used for the operation of this receiver while the electrical circuit of that power supply is illustrated in Figure 4. A table of typical voltages as made with Weston 547 set tester is included in Figure 5.

Solenoid Inductances

Utilizing the highest type of solenoid coils the intermediate amplifier transformer, correctly designed, has produced a very high gain per stage. It was the natural supposition that with the tremendously high gain obtained it would not be practical to use many stages of this type. Contrary to this belief, however, in the Lincoln Ten five tuned intermediate stages were successfully used building up a total intermediate amplification exceeding anything previously known to the designer.

Combined in this system each stage is accurately tuned by a high grade low loss stator and rotor type condenser, tuning the plate circuit of the screen grid tube. The overall of the five operative tuning units produces a high degree of rejectivity from the undesired frequency.

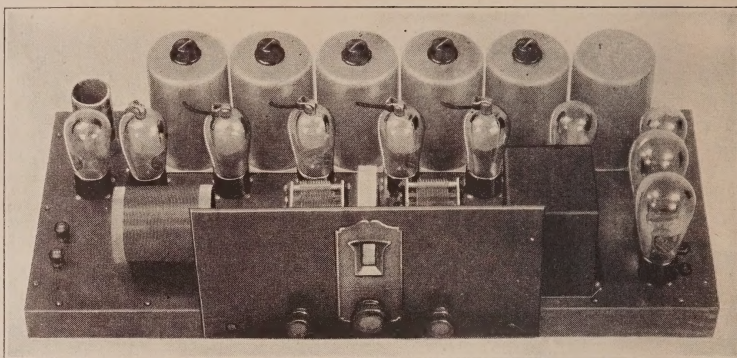


Fig. 1. In this photograph may be seen the front and top view of the Lincoln DeLuxe Ten with all tubes in place

The wave length range is from below 220 meters and up to 550 meters. A space wound oscillator coil is also used and both the input and the oscillator are tuned by a .0005 mfd special variable condenser. The antenna coil in the Lincoln DeLuxe Ten is a large sized one, space wound, using No. 16 enamel wire for the inductance.

227 Oscillator

The oscillator in this model is the type 227 while the first detector is a 224. Then follow four 224's as intermediate stages with a 227 as second detector and a 227 as the first audio. Two of the 245 tubes are used in push pull for the power stage. The chassis of the receiver combines a filament and heater supply transformer with a large safety factor. A bakelite sub-panel is used which is supported by a rigid hardwood frame extending from four sides.

According to the designer the stability of the new type of intermediate transformers was proven by laboratory experiments in which ten intermediate stages were successfully operated with perfect control without oscillating or distortion.

The DeLuxe Ten has an auxiliary plate supply furnishing adequate voltages for the receiver as well as 150 volts at 60 mils for excitation of the dynamic speaker field.

Preliminary Tests

The performance of the DeLuxe Ten has exceeded the expectations of the designer according to the statement recently made after a preliminary test of the first model finished. This test was made at Oak Park, Illinois, eight miles from the center of Chicago and in the center of the ring of Chicago's broadcasting stations. At that time

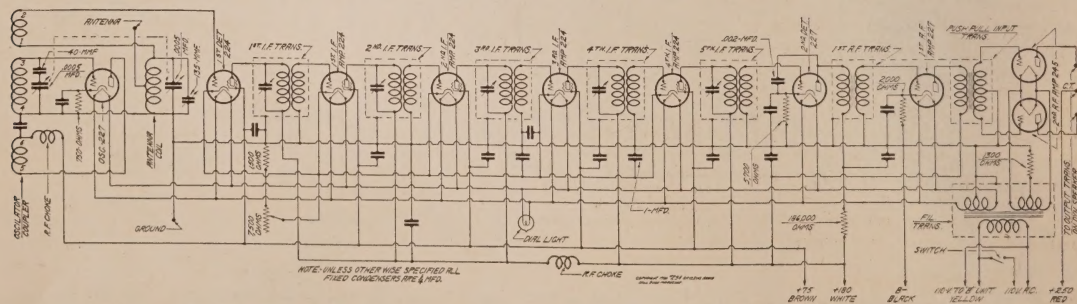


Fig. 2. The schematic diagram of the receiver is set forth in the above illustration

twenty-five outside stations were played at 12:30 noon. The number of stations received ranged from Hot Springs, Arkansas, down to Birmingham, Alabama; Schenectady, New York; Ft. Worth, Texas and Denver, Colorado. Others were played with considerable volume although the noise level was perceptible on many of them. On repeated tests made at the same location starting at 550 k. c. every channel was played down to 1500 k. c.'s.

For the benefit of those interested in the factors which determined the choice of intermediate coupling in this receiver we are reproducing some of the ideas of the designer as set forth in the following paragraphs:

Which Coupling Desirable?

As is known the transformer has proved to be the most practical and efficient means of coupling vacuum tubes for making a cascade amplifier. There are four variations of transformer coupling; namely, untuned, tuned primary, tuned secondary, and tuned primary and secondary.

The untuned transformer is very suc-

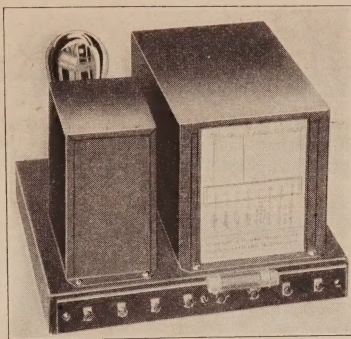


Fig. 3. This photograph is that of the power supply used in connection with the Lincoln DeLuxe Ten

between three-electrode tubes for a condition of instability and tendency for oscillation appears when the gain reaches a certain value per stage. The maximum gain, of course, would be reached with good shielding, by-passing of each stage to eliminate coupling by common impedance, and neutralizing. There would be no object in using a

however, has radically different properties from the three-electrode tube. The presence of a shield between the grid and the plate reduces the capacity between the grid and plate. The shield does not materially change the input capacity which is the grid to filament capacity, but the plate to filament capacity is considerably increased.

This means that the short circuiting effect of the output capacity of a shield grid tube is several times the short circuiting effect of its input capacity. Since tuning either the primary or the secondary of a transformer has the effect of removing either the output capacity or the input capacity respectively, the idea is immediately suggested to tune the primary.

The effect of the shield is to greatly increase the plate to filament resistance from a value of less than 20,000 ohms to a value on the order of 500,000 ohms. With the three-electrode tube it was not very difficult to get a primary impedance at least equal to the plate to filament resistance of the tube.

A tuned secondary transformer which was satisfactory for the three-electrode tube having a primary impedance of possible 50,000 ohms would give very little gain when used with shield grid tubes because of the very small proportion of the total plate circuit impedance which the primary of the transformer would represent. A tuned primary would, however, have a very high impedance and would make it possible to get a much larger proportion of the voltage generated in the tube across it. It is evident that, if the primary impedance of the transformer was equal to the plate to filament resistance of the tube, that only one-half of the voltage would appear across the primary. From these considerations, it is easily seen that the primary of a transformer used with shield grid tubes must be tuned. In the case of the shield grid tube, the plate to filament resistance is so high that its effect upon the tuned primary in producing an equivalent series resistance is negligible. This means that there would be no loss in selectivity in tuning the primary, but a considerable increase in voltage amplification would be effected.

(Continued on page 130)

Lincoln Tube Analysis

No.	Type	Position	Fil. "V"	"B"	C	M.A.	Grid	Cont. Grid.	K. "V"
1	227	Osc.	2.3	120	-6	6.5	7.5	---	+6
2	224	1st Det.	2.3	140	+30	.25	4.5	Off scale	+11.5
3	224	I.F.	2.3	140	+30	.25	4.5	Off scale	+11.5
4	224	I.F.	2.3	140	+30	.25	4.5	Off scale	+11.5
5	224	I.F.	2.3	140	+30	.25	4.5	Off scale	+11.5
6	224	I.F.	2.3	140	+30	.25	4.5	Off scale	+11.5
7	227	2nd Det.	2.3	60	-20	.75	1.0	---	+20
8	227	1st A.F.	2.3	180	-12	5.0	6.0	---	+11.5
9	245	P.P.	2.4	220	-48	18.5	23.0	---	---
10	245	P.P.	2.4	220	-48	18.5	23.0	---	---

Fig. 5. Using a Weston 547 tube tester, the typical voltage analysis of the receiver described here may be seen in the above table

cessful in low frequency amplifiers, but at high frequencies, very little gain can be obtained because of the short circuiting effect of the input impedance of the 3 element vacuum tube.

At a frequency of 500 kilocycles it is possible to get an impedance of several hundred thousand ohms from a tuned circuit. This impedance increases with both the efficiency as well as the inductance of the coil. In the three-electrode tube with a plate to filament resistance with less than 20,000 ohms it does not take a very large impedance in the primary of the transformer in order to get a considerable portion of the voltage generated across the primary. This means that it does not take very close coupling between the primary and secondary of a tuned secondary transformer to get sufficient reflected impedance into the primary.

Instability Appears

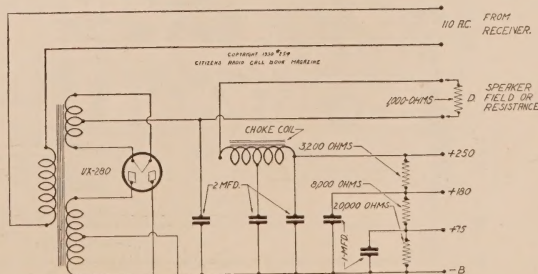
It is not possible to get all of the gain out of a transformer when used

tuned primary and tuned secondary transformer for coupling three-electrode tubes because all of the gain obtained by tuning only the secondary cannot be used even with perfect shielding and neutralizing.

From these considerations, it is very evident why it has been standard practice in designing transformers for coupling three-electrode tubes to use the tuned secondary method.

The four electrode shield grid tube,

Fig. 4. The electrical circuit of the power supply which is illustrated in the photograph at the top of this page may be seen in the schematic diagram printed here



New Design Is Seen in Pilot P-E-6 S. G. Broadcast Receiver

Two Radio Frequency Stages Employ 224's, While the Detector Uses a 227; 171 Push-Pull in Audio

MANY radio experimenters, custom set builders and professional service men have the idea that a screen-grid receiver, in order to be selective, must incorporate complicated band-pass tuner circuits and other tricks. This is true only if the designer or builder of the set intends it for use with an aerial of the dimensions many have become accustomed to; that is, an outside exposed wire totaling between fifty and two hundred feet in length. With a pick-up system of this size, and with the enormous amplification afforded by even the early stages of a screen-grid receiver, the intermediate stages overload very quickly, act as detectors, and cause the mysterious "cross talk" effects so common to many present-day factory outfits.

In talking about the admittedly high amplification of the screen-grid tube, radio writers and even many otherwise qualified radio engineers lose sight of its poor power-handling capacity. Its maximum allowable grid swing for good amplification, along the straight

section of the grid voltage-plate current curve, is only $1\frac{1}{2}$ or 2 volts, as compared to 14 volts for a 227 type tube. Even a single screen-grid r. f. stage, preceded by a long aerial, will affect the following tube to this extent. Very strong local signals will frequently be rectified by the very first tube, and will "ride" in on the loud speaker regardless of what wave the set is actually tuned to. If the first r. f. stage is of the so-called "untuned" type this effect will

be particularly aggravating. They shielded both tubes and coils to prevent signal pick-up by these instruments themselves. The receiver thus works with satisfaction on an indoor aerial eight or ten feet long; with a very long aerial it is naturally more productive of signals, but then the selectivity starts dropping. The point to emphasize is that it is a wholly effective set with an indoor aerial, and on this basis it is offered to set builders

(Continued on page 115)

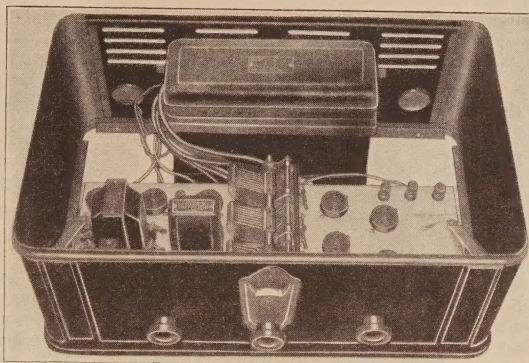


Fig. 1. Photograph of the completed receiver is here shown

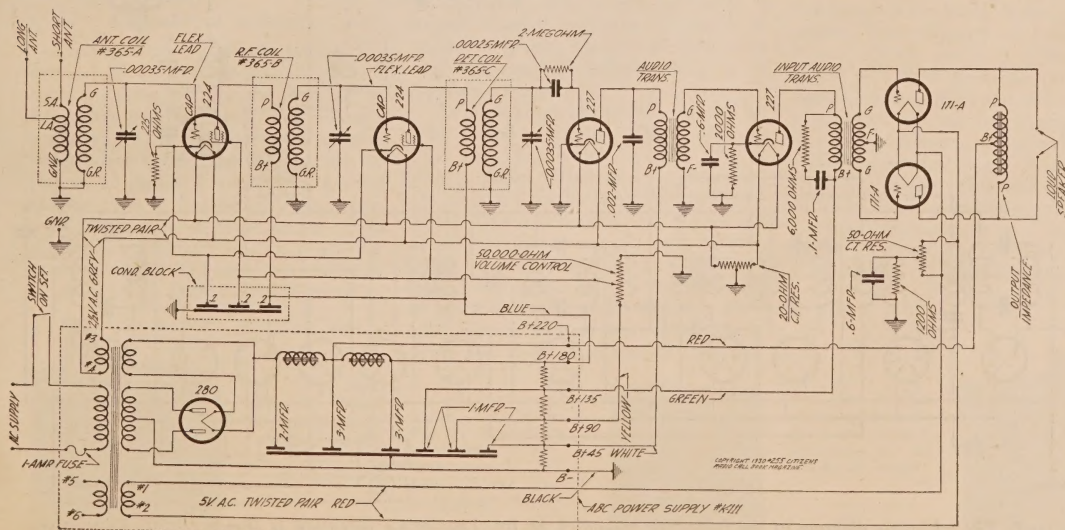


Fig. 2. Electrical details of the Pilot P-E-6 broadcast receiver are shown in this schematic

Theremin Produces Musical Tones By Beat Frequencies

Variation of Proximity of Operator's Hand to Control Electrode Changes the Tonal Notes

SINCE the announcement during the Radio Show this year of the Theremin, a musical instrument using radio fundamentals, merchandised by the Radio Corporation of America through musical outlets, there has been considerable interest on the part of readers in this particular device.

Many Applications

Accordingly we are showing photographically and schematically some of the features of this particular system of musical production invented by L. S. Theremin. Dr. Theremin's original application was filed on December 5, 1925, and patent was issued on February 28, 1928, under the number 1,661,058. In Germany his patent application was filed December 8, 1924. The patent applications and the granting of the patent brings to a close a number of years of arduous work on the part of the inventor to perfect the system of utilizing beat frequencies to produce musical sounds. How well he has succeeded in his endeavor may be seen by those who have listened to the Theremin played at the various radio shows and in other demonstrations.

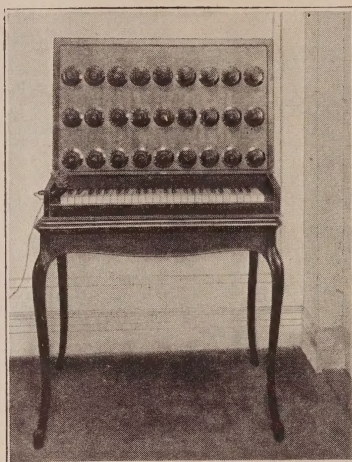


Fig. 1. The instrument shown in the photograph above is an electrical piano, one of the several variants of the Theremin. It plays chords, the tonal characteristics of which may be varied to as fine a degree as $1/100$ of the tone

With the method and apparatus for the generation of sound established by

Dr. Theremin, those interested in the technical end can readily see the vast number of applications that may be made beyond the construction of a single apparatus.

Electrical Piano

For example in the photograph shown in Figure 1 may be seen one of the Theremin devices which is an electrical piano on which chords can be played. Each tone can be tuned to $1/100$ of a tone by means of variations in the oscillating circuit. In the photograph the keyboard may be seen at the lower front while the controls permitting the tuning of individual notes may be seen above.

In the schematic diagram shown in Figure 2 is given the basic circuit from which all the modifications may be made. This diagram is that of a complete instrument for two tones. While the patent papers contain a number of other schematics it was thought that this one gives a general idea of the system and in the interest of space conservation we are only printing this particular drawing.

Another interesting application may (Continued on page 127)

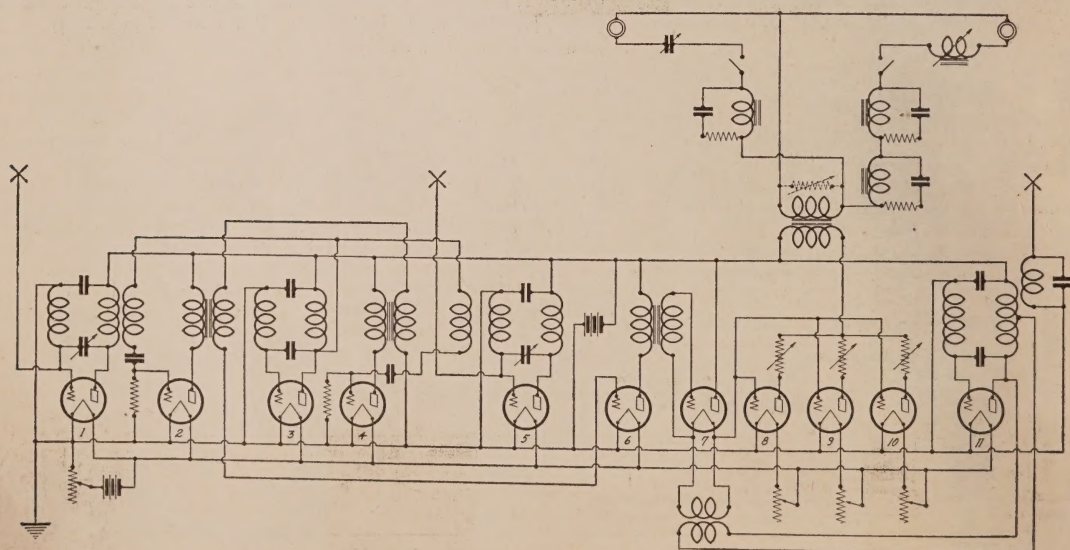


Fig. 2. The schematic diagram of the basic idea embodied in Dr. Theremin's invention is shown in this illustration. In the patent application, however, there are many schematic drawings but lack of space permits the use of only one of a characteristic type

Chemical Action and Capacity in Storage Battery Described

Proper Care Must Be Given Cells If Maximum Satisfaction and Service Are to Be Secured

(Part II)

CORRECTION

[The formulas in paragraph 2, column 2, page 114, Volume 10, No. 4 should read PbO₄ and PbO.]

IN Part I of this article there was discussed the various parts that go to make up the lead-acid storage cell, and the methods of the manufacture from the raw material to the completed cell. The purpose of Part 2 of this article is to familiarize the user of such a battery with the chemical operations of the lead acid cell, its usual troubles and rectifications of same in order that the greatest amount of service may be obtained from the storage batteries. At its best, the storage battery is a very inefficient electrical device and when given the average care which they usually receive such as over-charging, under-charging, not having the proper amount of water, etc., the storage battery usually does not last for any length of time, whereas if the storage battery has the proper care it will last for a great length of time and give an abundance of satisfactory service.

Capacity of Battery

The capacity of a storage battery is a product of the current drawn from the battery multiplied by the number of hours this current flows. Theoretically a battery has a capacity of 40 ampere hours when it furnishes 10 amperes for four hours and if it is unable at the end of that time to furnish any more current. If we drew only one ampere from this battery it should be able to furnish one ampere for 40 hours. The capacity of the battery should be the same no

matter what current is taken from it. However, a storage battery should not be discharged to a lower voltage than 1.7 volts per cell. The factors upon which the capacity of storage batteries depend are grouped in two named classifications: First, the design and construction of the battery. Second, the conditions of operation. Each of these classifications may be sub-divided into a great number of divisions, each one materially affecting the capacity of the battery. However, the most important of these sub-divisions is the area of plate surface. It is evident that the chemical and electrical activity of the storage battery are greatest at the surface of the plate, since the acid and active material are in intimate contact here and a supply of acid is more readily available as the battery is discharged. Therefore, it may be said that the capacity of a storage battery will be greater if the surface area of its plate



Fig. 2. A positive plate ready for use

is increased with larger plates or a greater number of plates. There is, of course, a greater amount of plate area and acid available which results in an increase in capacity.

As an analogy of capacity ratings we will consider the two water tanks in Fig. 14. The water in tank "B" is placed under a pressure by means of the weight *T* which floats on top of the water. We will assume that this weight is six pounds per square inch, as indicated on the gauge *D*. In the larger tank *J* the weight is of a size sufficient to place the water under the same pressure of six pounds per square inch. When the valve *E* is opened the water

in tank *B* will flow through this pipe *F* at a rate which we will say at ten gallons per minute. As this tank holds sixty gallons it will be readily seen that it will be empty in six minutes. If the valve is opened in tank *C* and the water drained is at the same rate as from the smaller tank which was ten gallons per minute it will be seen that it will take ten hours to empty it as the last tank holds 100 gallons. This will show that it will take longer to empty the larger tank than the smaller tank at the same rate of water flow. From this the capacity of the larger tank is greater than the capacity of the smaller tank in what we may term in gallon hours.

Using an Analogy

Referring to Fig. 13 this analogy can be applied to the storage battery. In Fig. 13 we have two storage cells. Each of these cells has a voltage of approximately two volts when there is no current drain. Both of these cells have the same electrical pressure, which is two volts. If the switch *B* is closed cell *A* when fully charged will deliver current to the light *F* which we will assume to draw current at the rate of five amperes. Assuming that these lights will burn at their rated brilliancy for ten hours, cell *A* would then discharge at the rate of five amperes for twelve hours, giving an ampere hour capacity of sixty ampere hours. If the switch *E* is then closed cell *B* will then discharge through the light *F*. These lights also draw five ampere hours with the length of time that this current is connected to the light due to the larger plate in cell *B* is increased to twenty hours. Then the capacity of cell *B* is 100 ampere hours.

From this it will be seen that the capacity of a cell is dependent upon the plate area. This means that smaller

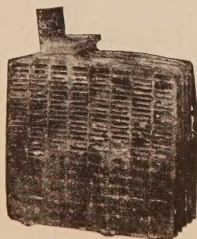


Fig. 1. Over-heated group of plates caused by excessive sulphation

Fig. 3. A positive plate from a battery which has been frozen due to lack of charge

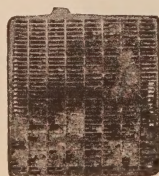
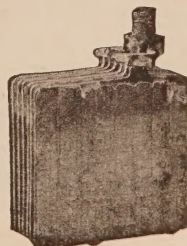


Fig. 4. Group showing excessive sulphation on plate due to lack of water



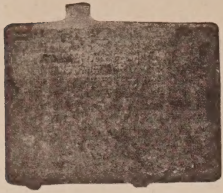
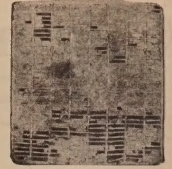


Fig. 5. Appearance of an under-charged plate



Fig. 8. Shows typical worn out separators

Fig. 10. Another plate from a frozen battery



plates but a greater number of plates may be used, just as well as a larger single plate to obtain the same capacity hours rating. The voltage of the storage cell is independent of the number of plates in the cell, but the voltage will drop with the time discharge at a certain rate due to the chemical changes which take place, so it is necessary to set a voltage cut-off so as to determine the time of discharge. The higher the ampere drain the faster the battery will discharge. This cut-off voltage is usually set according to the lowest voltage at which the apparatus being used with the storage cell or battery will operate at the current which it draws.

are rated according to which service the battery is to be put and the conditions under which it has to operate. There is the five ampere capacity rate, meaning the capacity obtained by discharging the batteries at five amperes. All capacity rates are based at 80 deg. F. There is then the twenty hour rate which is the capacity by discharging at a rate which will discharge the battery in twenty hours. Then there is a capacity upon the twenty minute rate. This is a capacity which is obtained by discharging the battery at a rate which will discharge it to its cut-off voltage in twenty minutes. The farm lighting batteries or stationary batteries are rated at the eight hour rate or intermittance rate which is the 72 hour rate at normal temperature. Radio batteries are rated at the 100 hour rate. The 100 hour battery based on the radio rate would mean a battery which would deliver 1 ampere for 100 hours at a cut-off of 1.75 volts per cell. While a 100 ampere hour battery rated at the five ampere rate would deliver five amperes for twenty hours under the same condition. If the first battery was rated at the five ampere rate it would only deliver five amperes for 13.4 hours. Each battery would have the capacity to do the work for which it was designed for but the capacity would be based on different rates. For this reason it is essential that the purchaser or user of the storage battery should be careful in the type of storage battery he is using to get the most service out of it. As will be noticed all capacity ratings have been based at 80 deg. F. temperature. This is due to the fact that the capacity of the storage cell will vary with the temperature and 80 deg. has been selected as the standard operating temperature.

Referring to Fig. 15 will show the difference in capacity for a change in temperature.

In order to further understand the capacity and operation of the lead-acid storage cell it will be necessary to un-

derstand a little of the electrical chemical action within the cell. If we should examine a storage battery which has been completely discharged and test the electrolyte and the materials on the plate we would find that the electrolyte was pure water and both sets of plates composed of white sulphate. And if we should make a like test on the plates and electrolyte of a storage cell which has been fully charged we would find that the electrolyte is now composed of water and sulphuric acid, the water being about 70 per cent and the acid about 30 per cent of the electrolyte. The negative plate would now be composed of pure lead in extensive form and the

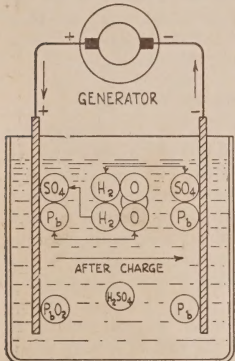


Fig. 6. Illustrates the chemical change after the storage cell has been charged

Capacity Varies

Referring to Fig. 16, from a careful study of this graph it will be seen that the ampere hour capacity of the storage battery varies with the rate of discharge. It will be seen that the higher the discharge rate the less ampere hour capacity delivered from the battery. For this reason the user of a storage battery should use a battery which is adaptable for the use which it is being put. A battery which would be satisfactory for lighting purposes would not be satisfactory for automobile purposes and vice-versa. Commercially storage batteries

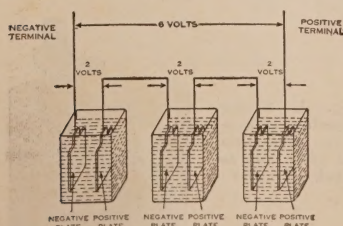


Fig. 7. Illustrates how three storage cells are connected in series



Fig. 9. Shows a group of badly buckled plates due to overheating

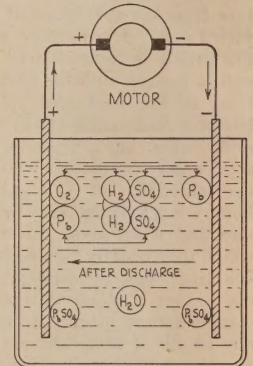
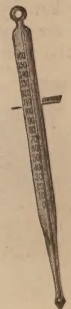


Fig. 11. Illustrates the chemical change after the storage cell has been discharged

positive plate would consist of peroxide of lead. The substances considered in the chemical action are sulphuric acid, water, pure lead, lead peroxide and lead sulphite. With the exception of the pure lead each of the substances is chemical compound composed of several elements such as sulphuric acid which is made up of two parts of hydrogen, which is a gas, one part of sulphur, which is a solid, and four parts of oxygen, which is a gas. These combine to

Fig. 12. Shows a temperature thermometer for a storage cell with the maximum heat at 110 degree, safe operating temperature



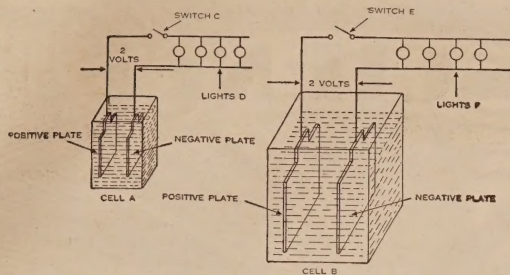


Fig. 13. This illustrates the difference in capacity ratings of a storage cell

form the acid which is in a liquid form and which is written chemically H_2SO_4 . H_2 represents the two parts of hydrogen, S the one part of sulphur and O_4 the four parts of oxygen. Likewise the water is made up of two parts of hydrogen and one part of oxygen which would be written chemically as H_2O . The pure lead which is an element and not a compound has a chemically sym-

stances of which they are composed, such as lead, hydrogen, oxygen and sulphur, making four elementary substances, two of which are gasses and two solids.

Sulphur, however, does not separate itself entirely from the compound, but split into H_2SO_4 and $PbSO_4$ respectively. This shows that the sulphur always remains combined with four parts of oxygen.

Now let us suppose that we have a single storage cell made up of one positive plate, one negative plate and electrolyte. When this cell is fully charged the positive plate is made up of peroxide of lead PbO_2 , and the electrolyte of dilute sulphuric acid H_2SO_4 .

When Cell Discharges

Referring to Fig. 11 we will illustrate what takes place when the cell is discharging and the result of the changes are that the positive plate, lead peroxide and sulphuric acid, produce lead sulphate, water and oxygen. Chemically written this would appear to be $PbO_2 + H_2SO_4 = PbSO_4 + H_2O + O_2$, and at the negative plate lead and sulphuric acid produce lead sulphate and hydrogen which would be written chemically as $Pb + H_2SO_4 = PbSO_4 + H_2$. The oxygen in the first equation and the

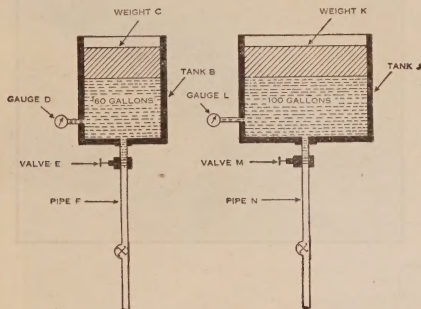


Fig. 14. A water analogy of capacity ratings

bol Pb . Lead sulphate which is a compound solid consists of one part of lead, one part of sulphur and four parts of oxygen. This would be written chemically as $PbSO_4$. Lead peroxide is also a solid and a compound and is made up of one part of lead and two parts of oxygen. In the changes that take place each compound split up into the sub-

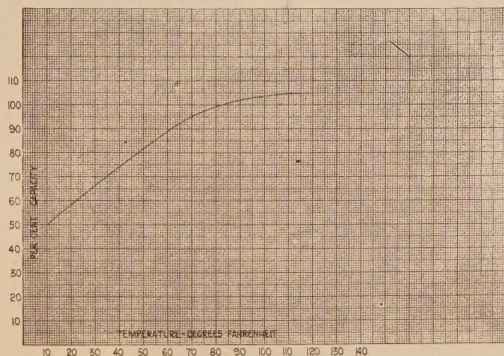


Fig. 15. Curve showing change of capacity with change of temperature

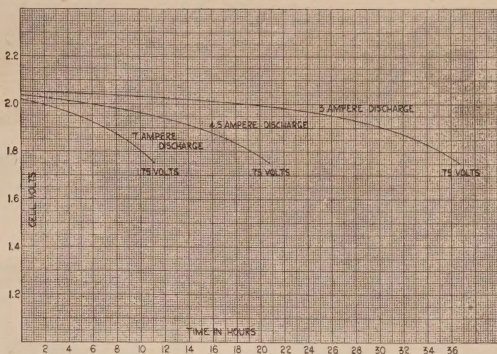


Fig. 16. Curves showing capacity at different discharge ratings

hydrogen of the second equation combine to form water, as will be readily seen by adding the two equations, giving one equation with the entire storage action, which would be written $PbO_2 + Pb + 2H_2SO_4 = 2PbSO_4 + 2H_2O$. In this last equation we started with the active materials and electrolyte in their original condition and finished with the lead sulphate and water which are the products of the discharged condition. Upon examination we see that the acid of the electrolyte is used in forming lead sulphate on both positive and negative plates and is therefore removed from the electrolyte which may be said that during a discharging condition the acid goes into the plate. These chemical changes are not instantaneous upon the discharging of a battery, but are a slow process, the speed of which is determined by the rates at which the battery is discharged. The slower the discharge the slower the change and likewise the faster the discharge the faster the change. Referring to Fig. 6, supposing that we are now going to charge a cell which is completely discharged. When the battery's charging with lead sulphate and water will gradually be changed back into lead, lead peroxide and sulphuric acid. The lead sulphate

(Continued on page 115)

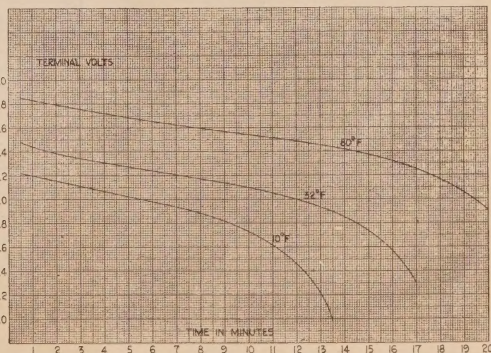


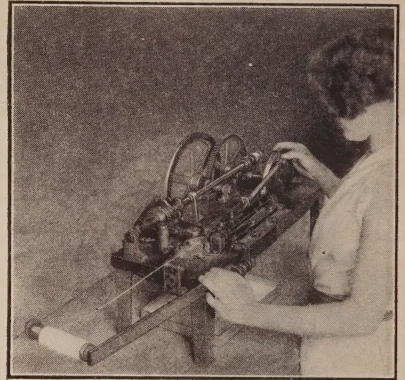
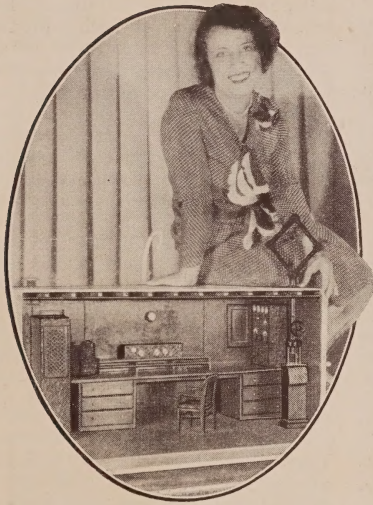
Fig. 17. Curves showing voltage decrease at different temperatures at constant current drain



Right. Nucrometer filament cutter in the Duovac tube plant, one of two such machines in existence, automatically and precisely measures, cuts and scrapes ends of the delicately coated filament wire heretofore cut, scraped and measured by hand

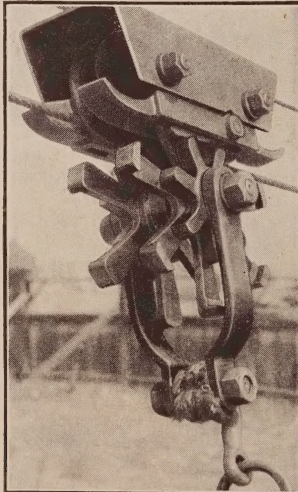
Wide World Photo

Left. Photo shows a model of a steamship installation which is valued at about \$10,000. It is shown with Miss Florence Levy, who is cashier for the radio operators, taking care of their finances while they are at sea. It was exhibited in the display of the Radio Corporation of America at the World's Radio Fair in Madison Square Gardens recently



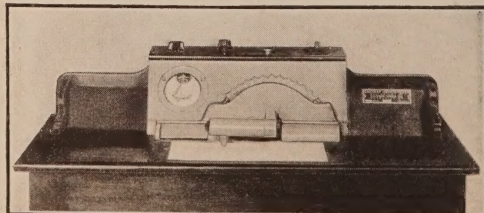
P. & A. Photo

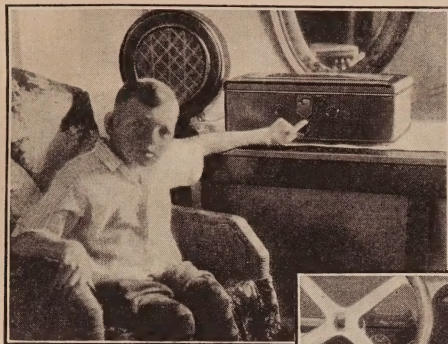
Left. Photo shows the new "Stepping Trolley" as it is called by its inventor. Its name is due to the fact that it steps over cable supports as though they were not there. The steppers or fingers are built in a circle, and when they hit a cable support they revolve, in that way stepping over the support. While they are revolving three of the fingers or steppers are always holding the load



P. & A. Photo

Lower right. A machine that exercises artistic judgment was recently displayed at the annual convention of the Master Photo Finishers of America, in Washington, D. C. It looks through a photographic negative with an electric eye and then stamps on edges of the film the grade of photographic paper the picture should be printed on and the degree of light that should be used, in printing it. The Printometer is the invention of Roland Wilkinson, of Jackson, Michigan





P. & A. Photo

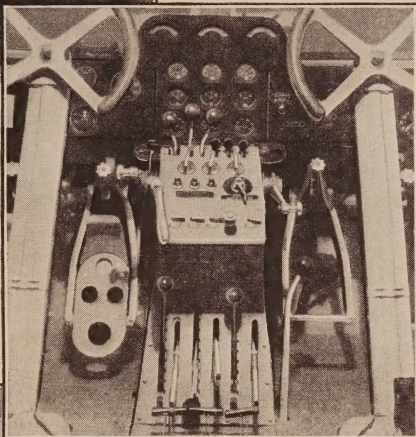
Left. Bobbie Farr, 12 years old, of Iowa City, Ia., with radio sent him by President Hoover, after he wrote the chief executive telling him how much he enjoyed his speech for the Golden Jubilee of Light through hook-up with a neighbor's radio set. Bobbie first became acquainted with the President when the latter stopped at Iowa City en route to home coming celebration at West Branch last August. The President spied Bobbie in the crowd and shook hands with him

P. & A. Photo

Below at right. This bottle-like object is a cathode ray tube which forms the receiver of the new type of television invented by Dr. Vladimir Zworykin, Westinghouse research engineer, who is seen holding it. The broadcast pictures appear on the round end of the tube and from there are projected on a mirror in view of the spectators

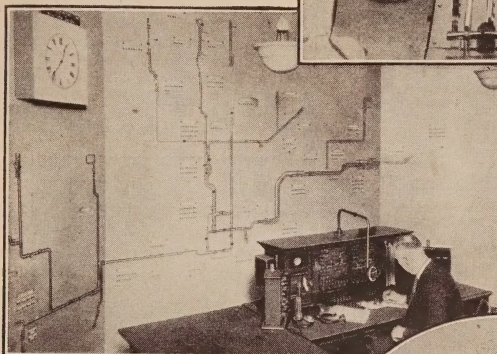
Wide World Photo

Right. One reason why giant tri-motored transport planes have two pilots is shown by this instrument board of the Boeing-San Francisco - Chicago transport. These planes have ninety controls and instruments to aid the pilots while in flight



P. & A. Photo

Left. In the heart of Chicago's loop district and 15 miles distant from remote points of the electrified railroad it governs, is located this huge diagram, which furnishes a manual and visual key to all "juice" used on Rapid Transit lines highways, transporting hundreds of millions of people annually. A glance at the diagram, with its miniature red and green lamps, colored strips denoting power lines and blocks representing 35 power sources, tells in a moment the condition of the sources, idle or operating, and the sets of tracks energized by them. A figurative flick of the power supervisor's thumb would halt any one train or tie up the entire system



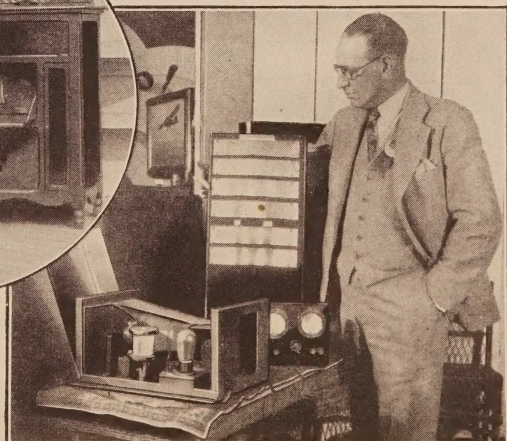
P. & A. Photo

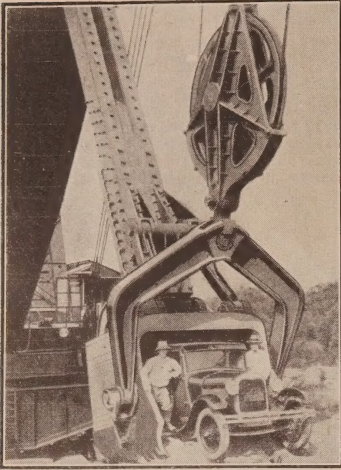
Right in oval. One of the many exhibits displayed on the deck of the U. S. S. California, on Navy Day. All items were made right on board ship. Shown are a radio cabinet, clock, candlesticks and picture frames



P. & A. Photo

At extreme right. A new device to guide airplanes to a landing field in a fog has recently been invented by Byrdette A. Palmer. The device consists of a captive balloon which contains several electrically controlled or automatic instruments which perform the following functions: 1. A fog indicator, to determine when the balloon is in and out of fog. 2. A large facsimile of an altimeter to indicate to pilot the height of the balloon above the airport. 3. A ceiling height indicator, to show pilot in air the extent of visibility below the fog. 4. Wind velocity indicator. 5. Wind direction indicator. 6. A sound detecting device to automatically throw on the airport siren and flood lights if pilot desires to land. 7. An instrument to show the pilot the number of the nearest airport where there is a ceiling of sufficient height for landing in case there is no visibility over the airport where the balloon is anchored. This balloon above the fog gives the pilot the necessary information for landing and a camera recording device in the balloon records in the station below, conditions in the air



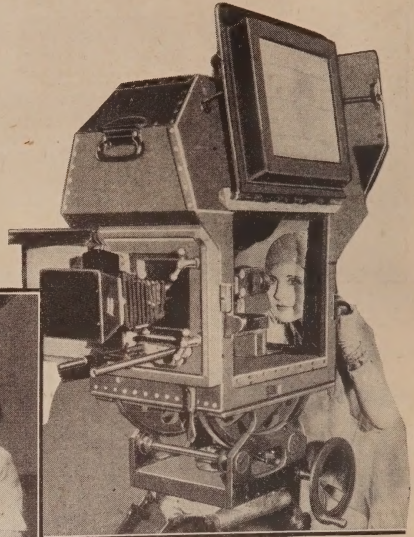


Wide World Photo

Above. The dipper or scoop of this huge new electric shovel, the largest in the world, will hold approximately 20 cubic yards. It was built for use in the Fidelity Mine of the United Electric Coal Company at Du Quoin, Illinois. One scoop would fill the average coal bin with its winter supply, and, as example of its tremendous power, could lift the load shown here and dump it on the roof of a seven-story building in less than a minute.

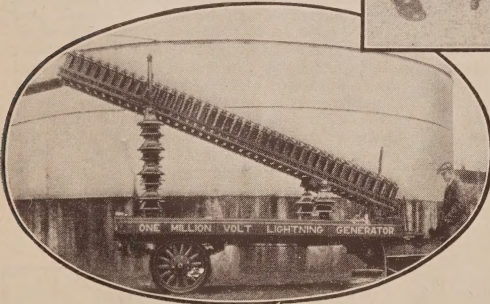
P. & A. Photo

Below. Dr. Vladimir Zworykin, Westinghouse Electric research engineer, is seen demonstrating his new cathode ray television set which can entertain large groups instead of one or two spectators. The broadcast images are projected on a mirror on the top of the cabinet making it possible for many to watch.



Wide World Photo

Above. Norma Shearer, Metro-Goldwyn-Mayer star, inspects the newest development in talkie photographic inventions, the sound-proof camera "bungalow" which eliminates the use of the unwieldy booths and permits the same sweep of camera action as in silent pictures.



P. & A. Photo

Above. This photo shows the recently completed million volt lightning generator, the only one of its kind in the world, built at the laboratory of the General Electric Company, at Pittsfield, Mass., where it was recently demonstrated.

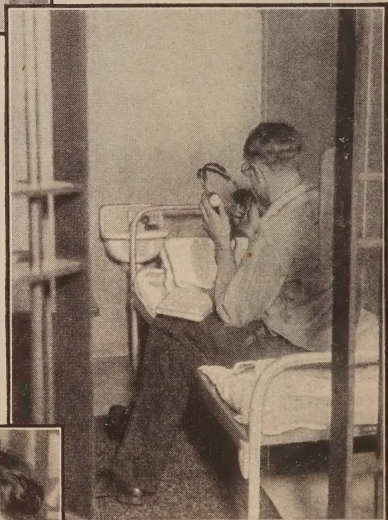
Wide World Photo

Right. An automatic testing machine has been devised which checks the performance of the completed radio chassis. This apparatus, which is being used in the engineering department of the Bremer-Tully company does the work of nine inspectors with accuracy and automatically registers any defects in the receiver. Photo shows an operator testing a radio chassis with the new apparatus which resembles a telephone switchboard.



Wide World Photo

Above. The many attractions of Sing Sing prison have been added to by the inclusion of a radio phone "Point" in each of the 800 cells in the new block. A prison official chooses the program and it is then relayed to the cells, this precaution being necessary to obviate the possibility of prisoners' friends talking to them via a nightclub microphone. Photo shows one of the inmates about to don a set of the head phones and listen in on a current program. Each cell is equipped with a set of head phones and there are over 2300 of them throughout the prison and also 21 loudspeakers.



POWER AMPLIFICATION



New York Power Amplifier System May Serve as Model for Others

*Nearly 1,000 Miles of Lines Used in Covering Vast Area; 25 Days
Allowed to Complete Work*

TO Albert Goldman, commissioner of the Department of Plant and Structures, City of New York, belongs the credit for the successful development of the plan to bring the music of the famous Central Park Mall concerts, as well as those given in Prospect Park, Brooklyn, to twenty-five other parks in the five boroughs of New York.

The idea of the above system originated with the present mayor of New York City, James J. Walker, early in the spring of this year, which idea he presented to Mr. Goldman to carry through to completion. Mr. Goldman placed the active charge of the work in the hands of the chief engineer of Plant and Structures, Edward A. Byrne, who detailed the city's chief radio engineer, Isaac Brimberg, to the task of actual supervision of the installation work to be done by the contractor.

Serve as Model

The specifications covering this installation, prepared by Chief Engineer Byrne and Chief Radio Engineer Brimberg, under the direction of Commissioner Goldman are especially outstanding in that they not only represent a pioneer effort but are so all inclusive that they should advantageously serve other communities whether smaller or even larger systems of like character are contemplated.

After two successful demonstrations and after a most thorough investigation into the history, the stability and experi-

ence of the Natural Sound Amplifying System, Inc., by the engineers appointed by Mr. Goldman, the contract was awarded to that company.

Chart Shows Area

The accompanying chart (Figure 3--Park Music Distributing System) will give the reader a fairly comprehensive idea of the vast area covered by the sys-

tem in the twenty-five parks, Central Park Mall and the Municipal Building. Nearly 1,000 miles of fire department telegraph cable were utilized to connect the amplifying system to and between the various parks in the five boroughs of New York City; eight parks in Manhattan, six parks in the Bronx, six parks in Brooklyn, three parks in Queens and two parks in Richmond (Staten Island).



Fig. 1. On top of the building at the right in this photograph may be seen one of the large Wright-DeCoster horns used in supplying voice and music entertainment to visitors at one of the New York parks



Fig. 2. This photograph shows the band stand in the Mall of Central Park. The band music is picked up by microphone from this position and relayed to all the various distributing stations in the New York park system.

The contract allowed twenty-five days for the completion of the work. The entire job had to be organized and its work planned in the minutest detail, between the dates of notification of the award of contract and of beginning of work—a period of two weeks. During this time equipment was specified, ordered and manufactured. Shipments were arranged so as to dovetail with the installation schedule. Any duplication of work had to be avoided because of the shortness of time allowed for the completion of the installation, particularly in view of the fact that a penalty was attached to the lack of such com-

pletion within twenty-five days. Each park had to be completely installed without necessity for return trips. Distribution of material and equipment was arranged for in advance of the appearance of the installation crew at each park. The completion of work in all parks in each borough had to synchronize with the completion of the panel installation in the fire department telegraph headquarters in each of the boroughs. All of this planning, to provide against all manner of disappointments and upsets, required experience and ability on the part of the engineering staff of the Natural Sound Amplify-

ing System and the full co-operation of the engineering division of the Department of Plant and Structures of the City of New York which was assigned to this work.

Checking Wire Characteristics

One of the chief difficulties encountered by the engineering staff was the determining of the characteristics of the wires running between the various fire department telegraph headquarters and the parks, as well as the characteristics of the wires running from the main headquarters in the borough of Manhattan (the central distributing point) and the associated headquarters in the remaining boroughs. Another major difficulty was the determining of the frequency characteristics of the allotted conductors. The system was designed to work with pair conductors and the allotted conductors were not of uniform lengths nor of the same kind of insulation, and some of the wires doubled back on themselves in order to reach their destination.

As an example of the above: between the Central Park pickup, at 72nd Street, and Battery Park at the lower end of Manhattan, a distance of about twelve miles, one conductor of the pair ran from Central Park Mall, where the concerts were given, to the 79th Street fire department telegraph headquarters, then to the Municipal Building, approximately eight miles, then back to 79th Street, then to Battery Park, while the other conductor of this pair ran direct from Central Park Mall to Battery Park.

Disconnect Speedily

It was necessary to supply a speedy means of disconnecting these fire department telegraph loops during the day so as to enable the fire department to use

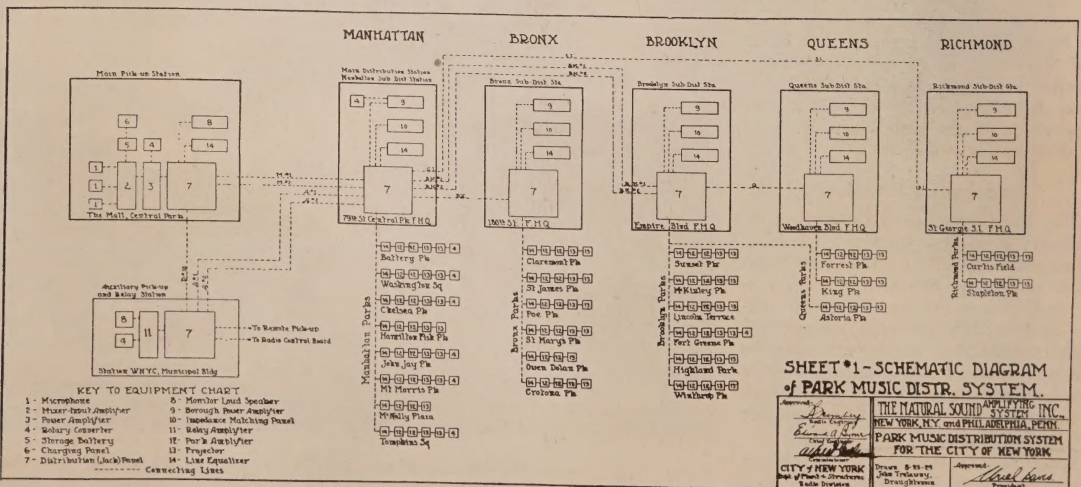


Fig. 3. This drawing shows a schematic diagram of the park music distribution system described in this article

them when necessary in its fire alarm telegraph system without disturbing the "balance" of the music distributing system.

The fire department telegraph system operates with a 67-volt common storage battery and the signals are transmitted by a mechanical means which causes this voltage to peak at as high as 300 volts on some of the parallel conductors associated with the pairs allotted for the use of the music distributing system.

Used One Crew

Because each of the twenty-seven installations offered a distinctly separate problem it was impossible to use more than one installation crew. This force was placed in charge of two engineers. The engineering staff and their co-workers were housed at the same address in order that nightly meetings might be held to discuss the problems of each day's work and to plan the work for the following day.

Dual amplifying equipment was provided in each park to allow for instant change-over in case of difficulty or disturbance of any sort, particularly as an insurance against disappointment on the part of the listeners.

Monitoring System

A highly important feature of the system is a method introduced by the engineers to automatically insure the satisfactory working of the system in the event of the non-working of any individual park or parks or wire section, for any cause whatsoever. Without such an arrangement the operation of the system would require a staff of operators whose sole duty it would be to keep



Fig. 5. At the Chicago municipal airport a speech amplifier is used for broadcasting arrival time and messages to the pilot while the planes are on the ground in front of the passenger station. The three Wright DeCoster speakers are shown above the railing in this photograph

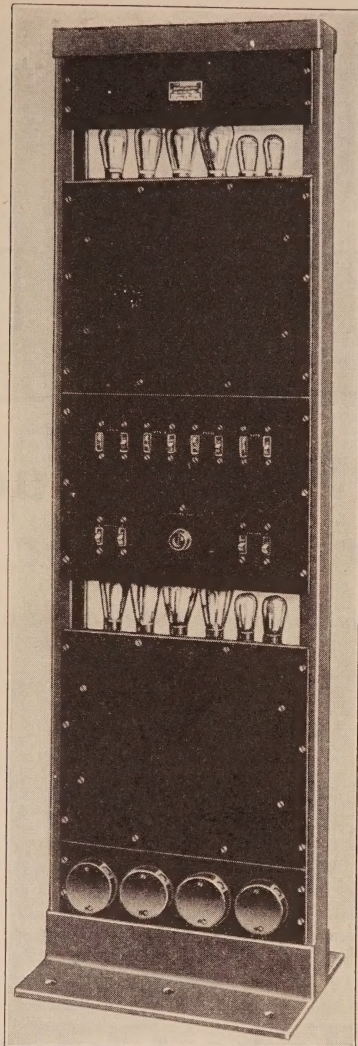


Fig. 4. One of the Samson amplifier panels used on this installation is illustrated in this photograph

in touch with each park to constantly ascertain whether the system was operating successfully during the period of each concert.

The operating personnel consisted of an attendant at each of the five fire department telegraph headquarters; an operator and an announcer at Central Park Mall (or at Prospect Park, Brooklyn, from which park band concerts were sent through the system over a connecting telephone line to the 79th Street fire department telegraph headquarters on evenings when no concerts were scheduled at Central Park Mall); an additional attendant for each borough to visit the parks in that borough each day to turn the systems on and report their condition to the chief radio

engineer. After the concert each evening, the superintendent or caretaker in each park turned the system off. The chief radio engineer could listen in at his office in the Municipal Building to ascertain just how the music was passing through the system to the various associated parks.

A telephone system between the various fire department telegraph headquarters was sufficient to keep the entire music distributing system under the control of the chief operator stationed at Central Park Mall or the chief radio engineer at the Municipal Building.

Prior to the completion of the installation Mayor Walker expressed a desire to dedicate the music distributing system. Within forty-eight hours after receipt of this message fifteen parks were hooked up and tested and on the evening of the dedicatory exercises, August 14, 1929, thousands of people in fifteen sections of New York City for the first time were able to hear Mayor Walker speak and the famous Edwin Franko Goldman Band play, at the same time enjoying the cool summer breezes in the public parks of the city.

The engineering staff of the Natural Sound Amplifying System was in charge of its chief engineer, Maurice A. Lichten, who was capably assisted by Messrs. E. M. Winecoff and Charles Stevens, associate engineers.

The horn shown atop the building in Figure 1 was a Wright-DeCoster with flare, while Samson amplifiers were used in the various distributing stations.



Fig. 6. One of the Silver-Marshall 690 amplifiers is illustrated in this photograph. At the right (not shown) is a modified 722 A. C. long wave receiver with which is picked up the data for plotting the isobars shown on the blackboard in the background. The microphone is located at the top and is used by the announcer for giving arrival and departure time of the planes from the Universal Air Line passenger station at the municipal airport, Chicago



Service Man Should Study All Types of Power Amplifier Systems

*Tubes Generally Cause Seventy-Five Per Cent of Amplifier Troubles;
Watch for Double Grounds*

By JOHN ERWOOD

[Chief Engineer, The Webster Co.]

DISCUSSION of power amplifier problems could be conducted along humorous lines except for the very sad fact that the subject is funny to neither the manufacturer nor the user. Only a very versatile comedian could extract any merriment from a talkie installation with a silent amplifier, and by the same token there is nothing involved in an inoperative coin-

in-the-slot machine which would tend to gladden the heart of its owner.

Difference of Degree

Analyzing the public address amplifier and the type of amplifier used in radio work, we readily see the only difference between them is one of degree. The service troubles are likely to be the same in either case. Both are power

handling devices. Greater power is expected from the public address or theater amplifier than from one used for radio. Many of the current models of radio sets may claim the right of classification in the power amplification group on account of the type of tubes employed in their output systems. However, many radio service men look askance and shrug their shoulders when

Arcturus Tube Characteristics

Type Number	Filament Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
22	15.0	0.35	---	---	---	135	-1.0	---	30	---	---	1.0	700,000	570	400	---	Det. & Amp.
26	15.0	0.35	---	22.5 45.0	1.0 2.5	---	+4.5 +9.0	---	---	---	---	---	---	---	---	---	Amplifier Detector
30	15.0	0.35	---	---	---	180	-27.0	1,227	---	---	---	22.0	3,500	1,085	3.8	---	Power
28	15.0	0.35	---	---	---	90	-1.5	200	---	---	---	7.5	9,000	1,165	10.5	---	Amplifier
32	15.0	0.35	---	---	---	135	-3.0	2,000	---	---	---	1.5	32,000	940	30.0	---	Amplifier
40	15.0	0.40	---	---	---	180	-40.5	1,928	---	---	---	21.0	2,000	1,500	3.0	---	Power
48	15.0	0.35	---	---	---	90	-4.5	1,000	---	---	---	4.5	9,200	1,185	10.0	---	Amplifier
126	1.5	1.05	---	---	---	135	-9.0	1,451	---	---	---	6.2	7,800	1,050	8.2	---	Amplifier
127	2.5	1.75	---	45	---	---	---	---	---	---	---	---	---	---	---	---	Detector
071	5.0	.50	---	---	---	135	-9.0	1,800	---	---	---	5.0	9,000	1,000	9.0	---	Amplifier
180	5.0	2.00	---	---	---	180	-40.5	2,025	---	---	---	20.0	1,500	2,000	3.0	---	Power
124	2.5	1.75	---	---	---	300	---	---	---	---	125	---	---	---	---	---	Rectifier
145	2.5	1.50	---	---	---	180	-1.5	---	75.0	---	---	3.8	400,000	1,050	420	---	Det. & Amp.
			---	---	---	250	-50	1,230	---	---	---	32.5	1,850	1,895	3.5	---	Power

RCA Tube Characteristics

Type Number	Filament Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
UX&UX199	3.0	.06	2-9	45	1	9	4.5	1,800	—	—	—	2.5	15,500	425	6.6	7	Det. & Amp.
UX-200A	5.0	.25	2-3	45	1.5	—	—	—	—	—	—	—	30,000	666	20.0	—	Detector
UX-201A	5.0	.25	2-9	45	1.5	90	4.5	1,800	—	—	—	2.5	11,000	725	8.0	15	Det. & Amp.
						135	9.0	3,000	—	—	—	3.0	10,000	800	8.0	55	Det. & Amp.
UX-240	5.0	.25	2-5	135	.3	135	1.5	—	—	—	250,000	0.2	150,000	200	30	—	Det. & Amp.
				180	.4	180	3	—	—	—	250,000	0.2	150,000	200	30	—	Det. & Amp.
UX-222	3.3	.132	—	—	—	135	1.5	910	45	.15	—	1.5	850,000	350	300	—	R. F. Amp.
UX-222	3.3	.132	—	—	—	180	1.5	238	22.5	6.0	—	0.3	150,000	400	60	—	A. F. Amp.
UX-226	1.5	1.05	—	—	—	90	6.0	1,620	—	—	—	3.7	9,400	875	8.2	20	Amplifier
						135	9.0	1,500	—	—	—	6.0	7,400	1,100	8.2	70	Amplifier
						180	13.5	1,800	—	—	—	7.5	7,000	1,170	8.2	160	Amplifier
UY-227	2.5	1.75	2-9	45	2	90	6.0	2,000	—	—	—	3.0	10,000	900	9.0	30	Det. & Amp.
						135	9.0	1,800	—	—	—	5.0	9,000	1,000	9.0	78	Det. & Amp.
						180	13.5	2,250	—	—	—	6.0	9,000	1,000	9.0	164	Det. & Amp.
UY-224	2.5	1.75	—	—	—	180	1.5	—	75	—	—	4.0	400,000	1,050	420	—	Det. & Amp.
UX-120	3.0	.125	—	—	—	135	22.5	3,470	—	—	—	6.5	6,600	500	3.3	110	Power
UX-112-A	5.0	.25	—	—	—	135	9.0	1,285	—	—	—	7.0	5,000	1,600	8.0	120	Power
						157.5	10.5	1,105	—	—	—	0.5	4,700	1,700	8.0	195	Power
						180	13.5	1,420	—	—	—	9.5	4,700	1,700	8.0	275	Power
UX-171-A	5.0	.25	—	—	—	90	16.5	1,650	—	—	—	10.0	2,500	1,200	3.0	130	Power
						135	27.0	1,690	—	—	—	16.0	2,200	1,360	3.0	330	Power
						180	40.5	2,025	—	—	—	20.0	2,000	1,500	3.0	700	Power
UX-245	2.5	1.5	—	—	—	180	33.0	1,270	—	—	—	26.0	1,950	1,800	3.5	780	Power
						250	50.0	1,565	—	—	—	32.0	1,900	1,850	3.5	1,600	Power
UX-210	7.5	1.25	—	—	—	250	18.0	1,800	—	—	—	10.0	6,000	1,330	8.0	340	Power
						300	22.5	1,730	—	—	—	13.0	5,600	1,450	8.0	600	Power
						350	27.0	1,690	—	—	—	16.0	5,150	1,550	8.0	925	Power
						400	31.5	1,750	—	—	—	18.0	5,000	1,600	8.0	1,325	Power
						425	35.0	1,945	—	—	—	18.0	5,000	1,600	8.0	1,540	Power
UX-250	7.5	1.25	—	—	—	250	45.0	1,605	—	—	—	28.0	2,100	1,800	3.8	900	Power
						300	54.0	1,545	—	—	—	35.0	2,000	1,900	3.8	1,500	Power
						350	63.0	1,400	—	—	—	45.0	1,900	2,000	3.8	2,350	Power
						400	70.0	1,275	—	—	—	55.0	1,800	2,100	3.8	3,250	Power
						450	84.0	1,525	—	—	—	55.0	1,800	2,100	3.8	4,650	Power

the subject of power amplification, a very remunerative field, is discussed. It is believed that their indifference to this field has resulted from one or two sad experiences with early products in this line. With the advance that has been made in this particular art, it is believed that most of the troubles have been removed.

Study Yields Results

Common sense is still just as requisite to the installation, operation and maintenance of power amplification systems as it is in any other calling. In addition to this it would seem that the more data secured and time spent on a study of the particular apparatus to be used in an installation would yield a greater dividend in satisfaction than any one other factor.

Continuous Service

From the standpoint of the user continuity of service is of major importance. The talkie installation with an inoperative power amplifier is embarrassing as well as a financial loss. The owner of a coin operated phonograph system faces loss of revenue and abuse

on the part of the customer to the machine if the installation is not working. The public address system is in an equally disconcerting position when inoperative and faces the disappointment of the audience. In order to maintain "on with the show" as a slogan perfect operation must be the goal.

When to Return it

The question of when an amplifier should be returned to the manufacturer for repairs can easily be answered. The only time that such an amplifier should be returned is when the service man

knows absolutely that the trouble is in the amplifier and not with the associated equipment. If he is able to make repairs in the equipment there is no need for returning the amplifier to its source.

Tube Troubles

Tubes themselves are probably responsible for 75 per cent of all amplifier troubles today, ranging from burned out units to excessive hum and distortion. There are several interesting side-lights on the question of tubes and their efficiency. Quite frequently a service man will say that the amplifier must be at fault because he took a set of tubes out of another amplifier and still the unit did not perform properly. This is a rather fallacious statement to make. The very fact that tubes in another amplifier have been operating properly does not necessarily indicate they will work best in a second amplifier unless both amplifiers are identically the same. Also it is quite possible that the tubes removed from one amplifier position may have been inserted in another position in the second amplifier. The only way to prove that the tubes are not

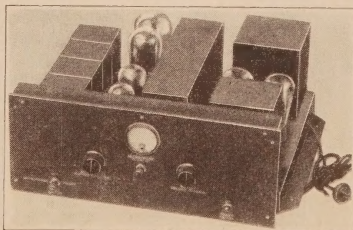


Fig. 1. This photograph shows a Webster DH 250 amplifier where microphone current is supplied in the amplifier

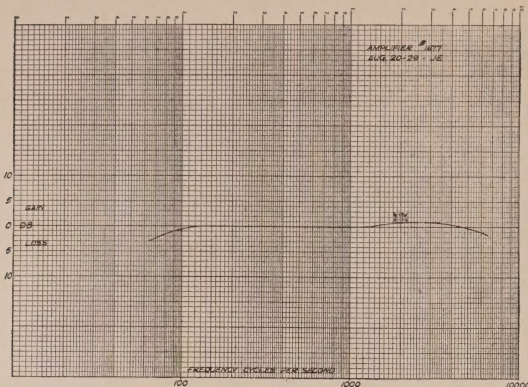


Fig. 2. The response curve on the DH 250 amplifier made by Webster is shown in the accompanying graph

at fault is to check each one of them completely before it is placed in the amplifier desired. Just because a tube is new or has operated perfectly in another amplifier is no indication that it will do so in a second one. Therefore, be sure to check the tubes before placing in the amplifier and recheck at regular intervals, as this will reduce interrupted programs.

Turn Off Set First

However, one must remember that in

checking tubes they should not be pulled out of the amplifier while it is operating because to do so is likely to cause a voltage surge on the remaining tubes that is sure to break down either the audio transformers or the condensers.

Where Hum Originates

Hum can often be traced to defective or shorted tubes, either in the stages preceding the last stage or in the last stage itself. Unbalanced rectifier tubes

also may cause excessive hum. Worn out tubes (low emission) frequently cause squealing and howling.

A peculiar and somewhat common type of distortion which occurs at high volume levels (a cracking or popping noise) can often be located in the mesh or base of the power tube, especially the 250 type of tube. The magnitude of the output transient causes breakdown of insulation and sparking. It, of course, goes without further mention that shorted or grounded elements in the tubes, will if left in the amplifier, burn out audio transformers, voltage divider or drop resistors, chokes and finally the power transformer itself. Again the first point to remember is to check the tubes and take nothing for granted.

The question of hum is one of importance. A hum level which is sometimes passable in one location will probably cause a great amount of discomfort in a place that is acoustically bad. For example, sounding waves are often set up. Again excessive hum causes a masking effect covering the lower frequencies.

Excessive Hum

Excessive hum can be caused by

Gold Seal Tube Characteristics

Type Number	Filament Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
GS199	3.0	.06	2-9	45	1	90	4.5	1,800	---	---	---	2.5	15,500	425	6.6	7	Det. & Amp.
GSX199	3.0	.06	2-9	45	1	90	4.5	1,800	---	---	---	2.5	15,500	425	6.6	7	Det. & Amp.
GSX200A	5.0	.25	2-3	45	1.5	---	---	---	---	---	---	---	30,000	666	20.0	---	Detector
GSX201A	5.0	.25	2-9	45	1.5	90	4.5	1,800	---	---	---	2.5	11,000	725	8.0	15	Det. & Amp.
								3,000	---	---	---	3.0	10,000	800	8.0	55	Det. & Amp.
GSX222	3.3	.132	---	---	---	135	1.5	---	---	---	---	1.5	850,000	350	300	---	Det. & Amp.
GSX240	5.0	.25	---	---	---	135	1.5	---	---	---	---	.2	150,000	200	30	---	Resis. Amp.
GSX226	1.5	1.05	---	---	---	90	6.0	1,710	---	---	---	3.5	9,400	875	8.2	20	Amplifier
						135	9.0	1,500	---	---	---	6.0	7,400	1,100	8.2	70	Amplifier
						180	13.5	1,800	---	---	---	7.5	7,000	1,170	8.2	160	Amplifier
GSY227	2.5	1.75	2.5	45	2	90	6.0	2,000	---	---	---	3.0	10,000	800	8	---	Det. & Amp.
			1/4-1	90	7	180	13.5	1,225	---	---	---	7.0	8,000	1,000	8	---	Det. & Amp.
GSY224	2.5	1.75	---	---	---	180	1.5	---	75	---	---	4.0	400,000	1,000	420	---	Det. & Amp.
GSX120	3.0	.125	---	---	---	135	22.5	3,620	---	---	---	6.5	6,300	525	3.3	110	Power
GSX112A	5.0	.25	---	---	---	135	9.0	1,285	---	---	---	7.0	5,000	1,600	8	120	Power
						157.5	10.5	1,110	---	---	---	9.5	4,700	1,700	8	195	Power
GSX171A	5.0	.25	---	---	---	90	16.5	1,000	---	---	---	10.0	2,500	1,200	3.0	130	Power
						135	27.0	1,695	---	---	---	16.0	2,200	1,360	3.0	330	Power
						180	40.5	2,025	---	---	---	20.0	2,000	1,500	3.0	700	Power
GSX245	2.5	1.5	---	---	---	250	50	1,560	---	---	---	32.0	1,900	1,850	3.5	750	Power
						180	33	1,270	---	---	---	26.0	1,950	1,800	3.5	1,600	Power
GSX210	7.5	1.25	---	---	---	250	18	1,060	---	---	---	17.0	6,000	1,330	8.0	340	Power
						300	22.5	1,250	---	---	---	18.0	5,600	1,450	8.0	600	Power
						350	27	1,350	---	---	---	20.0	5,150	1,550	8.0	925	Power
						400	31.5	1,370	---	---	---	23.0	5,000	1,600	8.0	1,325	Power
						425	35	1,510	---	---	---	23.0	5,000	1,600	8.0	1,540	Power
GSX250	7.5	1.25	---	---	---	250	45	1,610	---	---	---	28.0	2,100	1,800	3.8	900	Power
						300	54	1,540	---	---	---	35.0	2,000	1,900	3.8	1,500	Power
						350	63	1,400	---	---	---	45.0	1,900	2,000	3.8	2,350	Power
						400	70	1,270	---	---	---	55.0	1,800	2,100	3.8	3,250	Power
						450	84	1,530	---	---	---	55.0	1,800	2,100	3.8	4,650	Power

Triad Tube Characteristics

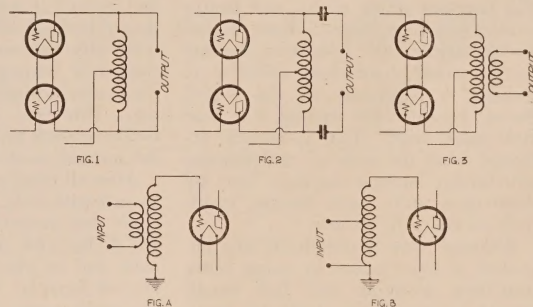
Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Amplifier (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
T-01-A	5.0	.25	2.5	45	1.5	45	1.5	1,765	---	---	---	.9	18,500	430	8.0	---	Det. & Amp.
					67.5	3.0	3.0	1,800	---	---	---	1.7	14,000	570	8.0	---	Det. & Amp.
					90.0	4.5	4.5	3,000	---	---	---	2.5	11,000	725	8.0	15.0	Det. & Amp.
T-22	3.3	.132	---	---	135	9.0	9.0	9,100	45	.15	---	4.5	8,600	1,000	8.0	55.0	Det. & Amp.
T-26	1.5	1.05	---	---	180	1.5	1.5	2,380	22.5	6.0	250,000	3.0	850,000	350	290	---	Amplifier
					90	6.0	6.0	1,700	---	---	---	3.7	9,400	875	8.2	20	Amplifier
					135	9.0	9.0	1,500	---	---	---	6.0	7,400	1,100	8.2	70	Amplifier
T-27	2.5	1.75	2.5	45	2.0	90	6.0	2,000	---	---	---	7.5	7,000	1,170	8.2	160	Amplifier
					135	9.0	9.0	1,800	---	---	---	3.0	10,000	900	9.0	---	Det. & Amp.
					180	13.5	13.5	2,250	---	---	---	5.0	9,000	1,000	9.0	---	Det. & Amp.
T-24	2.5	1.75	---	---	180	13.5	13.5	2,250	---	---	---	6.0	9,000	1,000	9.0	---	Det. & Amp.
T-12-A	5.0	.25	---	---	180	1.5	1.5	850	75	---	---	4.0	400,000	1,050	420	---	Det. & Amp.
					90	4.5	4.5	1,300	---	---	---	5.5	5,300	1,500	8.0	---	Power
					135	9.0	9.0	1,050	---	---	---	7.0	5,000	1,600	8.0	120	Power
					157	10.5	10.5	1,350	---	---	---	9.5	4,700	1,700	8.0	185	Power
T-171-A	5	.25	---	---	180	13.5	13.5	1,687	---	---	---	11	4,000	2,000	8.0	275	Power
					135	27	27	1,833	---	---	---	16	2,500	1,360	3	---	Power
					157	33	33	2,025	---	---	---	18	2,200	1,400	3	---	Power
T-45	2.5	1.5	---	---	180	40.5	40.5	1,350	---	---	---	20	2,150	1,500	3	700	Power
					250	50	50	1,550	---	---	---	26	1,950	1,800	3.5	780	Power
T-210	7.5	1.25	---	---	180	12	12	1,715	---	---	---	32	1,900	1,850	3.5	1,600	Power
					250	22	22	1,800	---	---	---	7	7,000	1,100	8.0	---	Power
					350	31	31	1,950	---	---	---	10	6,000	1,330	8.0	340	Power
T-250	7.5	1.25	---	---	425	39	39	1,950	---	---	---	16	5,150	1,550	8.0	925	Power
					300	54	54	1,500	---	---	---	18	5,000	1,600	8.0	1,540	Power
					350	63	63	1,400	---	---	---	35	2,000	1,900	3.8	1,500	Power
					400	70	70	1,300	---	---	---	45	1,900	2,000	3.8	2,350	Power
					450	84	84	1,550	---	---	---	55	1,800	2,100	3.8	3,250	Power
									---	---	---	55	1,800	2,100	3.8	4,650	Power

shorted bypass condensers, open audio transformers and bias resistors, shorted filter chokes and filter condensers, although the latter condition will manifest itself in over-heating of the rectifier tubes and power transformer. Occasional bad hum can also be traced to the fields from adjacent electrical equipment, such as mercury arc rectifiers, rotary converters, and small motors. Do not take for granted that audio units even if placed in a can will not pick up stray fields. Great care must be exercised that the input wiring to the amplifiers is well shielded from all a. c. wiring. A. c. pick-up is frequently a cause of trouble. In the event that a. c. excited dynamic speakers are used occasional hum will originate from the rectifier unit. This can be checked by disconnecting the amplifier output, leaving the a. c. field excitation on, and shorting the voice coil transformer. Base of amplifier should also be grounded to prevent hum.

Cause of Feedback

Another of the common causes of distortion and whistling in amplifier output is due to feed-back, regeneration, having the input and output wiring too closely associated, run in the same conduit. This cannot be done without dis-

Fig. 3. Common forms of input and output coupling mentioned by Mr. Erwood in his article are shown in the above sketches



astrous results.

Care must be exercised to properly insulate the speaker wiring against the surges imposed upon it. Break-down in junction boxes and fittings is not uncommon and causes a rattle in the speaker. The noise made under these conditions is similar to the one occurring in a break-down inside the mesh or base of the tube.

Coupling Methods

Three methods are in general use today as shown in diagrams 1, 2 and 3. In the event that the scheme in Fig. 1 is in use it is absolutely necessary to keep the system clear of grounds. A ground in the speaker wiring or voice coil

transformer will in all probability ruin the rectifier tubes and burn out the amplifier.

System No. 2 is the same as system No. 1 in that the load into which the amplifier looks must be the same. The advantage of this is that the d. c. is isolated from the speaker wiring.

Scheme No. 3 has the most points in its favor and gives the greatest flexibility. Scheme A is transformer input, while B is auto-transformer.

Watch Double Grounds

Some amplifier manufacturers ground one side of the pickup transformer winding inside the amplifier. Some installers ground one side of the pickup

winding externally. This is particularly true where a common fader is used for two amplifiers. In this case it is very important that the pickup be poled properly. Otherwise with the winding inside grounded in the amplifier, and again grounded externally (but wrongly poled) the pickup would be shorted out.

Fast Versus Slow Heater Cathodes

By C. F. STROMEYER

(Chief Engineer, Cable Radio Tube Corp.)

ANYTHING new or somewhat radical in design always goes through a very trying stage of rebuff issued from those who are prone to dogma. Certainly fast heating cathodes used in -27 and -24's are having their share. To ascertain the validity of this criticism, compare in detail both slow and fast heaters.

Slow heaters can be defined as those having a heater surrounded by a full sleeve insulator which heats conductively the thermionic emitting base. It is immaterial whether coil or hairpin heaters are employed. The indirect heating method produces a large time lag—thus slow heaters. The insulators and heaters both in manufacturing process and operating conditions reach dangerous fusing temperatures. Fusing troubles are attributed to many last year's -27 burn-out complaints, for the two constituents have different expansion coefficients. Something must give! The tungsten splits, opens, and finally renders the tube useless. Also, at the fusing points, the insulators become fair electrical conductors where a c. leakage is impressed on the coated sleeve, considerably raising the hum and noise level. Hot insulators extended from the ends of the cathodes will further increase the noise level by discharging stray static charges, which they periodically assume.

Although slow heaters have been improved to some extent by using better insulating material and full length sleeves which totally shield the insulators, they are not without question better than fast heaters.

Cathodes whose emitting bases are directly heated by heater radiation can be classed as fast heaters. Some employ centering plug insulators at each end, but this in no way defeats radiation. If designed properly, the plugs operate comparatively cool—consequently no fusing or static discharges are possible. Coil heaters, even at their low operating frequency, can inductively introduce a. c. on the coated sleeve; but if the coil diameter is kept small compared to the metal sleeve, this effect becomes negligible.

On the other hand, the hairpin type is free from this effect; but because of

their geometric proximity, the heater must be coated with an insulating material to prevent heater to cathode shorts. This material is in the neighborhood of a few thousandths of an inch. No burn-out difficulties, as previously mentioned, are encountered, but hum conditions remain. If a heater does lay up against a metal sleeve, there is grave danger of an insulation breakdown, especially when the heater becomes excessively hot or a high potential difference exists between the two. In producing coated heaters, a production short test does not reveal the story. Tubes may go to the consumer with heaters completely out of alignment. Even with these difficulties, one manufacturer is successfully making a hairpin type, but he uses a special low temperature heater.

All metals under certain conditions emit electrons. The current flow from heater to sleeve is objectionable. Common practice balances this out by biasing the metal sleeve. Fast heaters in this respect are on a par with their opponents. By what reasoning should anyone conclude that a fast heater's life span is less when the same type of emission coating can be used on both types? The sensitivity of the coating is not effected—so no increase in temperature is necessary. The nickel base may remain the same. They can without question stand more heater voltage overload. The mechanical constructions are not necessarily weaker because the insulators are removed, for the sleeve may be supported in some other way. It may be well to mention that fast heaters do not heat instantaneously as stated in some advertisements. It is ambiguous to state their heating time without setting some standardization of measuring the lag. However, they average about twelve seconds for optimum volume under normal conditions.

After all these principles were proved by extensive tests, our laboratories conclude that properly designed fast heaters of the coil type were an achievement and so placed them on the market last January. The only positive way we could prove the validity of these statements was through our consumer acceptance. It is gratifying to state that they are satisfied and returns have dropped to a minimum figure.

Where is the catch? The increased cost of manufacturing fast heater is almost half again as great, yet the selling price remains the same. No wonder some manufacturers will not change!

What Address, Mr. Bates?

MANY of our readers have requested resistance, capacity, transformer and other values covering the Universal ABC Power Supply with Master Power Amplifier which appeared on page 71 of the September,

1929, edition. The information is now available and we shall be glad to pass it on to those desiring it.

We have a letter in our files from Henry W. Bates wherein he asks for additional data on this particular unit. However, failing to give us his address, we were unable to assist him. Perhaps the above note will come to his attention.

Short Life of Tubes in Brunswick and Bremer-Tully Receivers

Complaints have reached Sylvania Products Company regarding short life of 227 and 224 tubes in Brunswick and Bremer-Tully receivers, according to a recent bulletin from W. R. Jones, sales engineer of that company.

Extensive investigation has proven that in most cases where this has occurred a voltage regulator Type 105 or Type 110 has been employed and the heater voltage has usually been higher than 2.6 volts, and thus shortened tube life. The Brunswick Company are now recommending a Type 98 voltage regulator. The same applies to the Bremer-Tully receiver.

Replace the present voltage regulators with Type 98 and tube difficulties should end.

What City, Mr. Daugherty

We recently received an inquiry from R. Daugherty, 2113 N. Charles Street. Mr. Daugherty neglected to give us the name of the city where he resides, so we are unable to reply until such information is received. If Mr. Daugherty sees this, we would appreciate learning from him the city of his residence.

Radio Noises and Cures

A booklet "Radio Noises and Their Cure" has just been announced by the Tobe Deutschmann Corp. at Canton, Mass. It is replete with suggestions and ideas for noise elimination. The manual sells for 25 cents and may be secured from the address given above. Please mention this magazine when writing.

Unbalanced Rectifiers

Several service men have called attention to the fact that some hum in the present-day receivers has been found to have been caused by a difference in the emission of one of the rectifier plates in a 280. For example: the maximum current output from the 280 is 125 mls which would make approximately 62½ mls per anode. If there is a deviation of much more than 20 per cent of the anode current in one, hum possibilities exist. In the absence of a means of checking the individual anode current reading, the best test is a spare 280 carried in the kit.

Slagle Model 9 Receiver and Supply

THE Slagle model 9 receiver and power supply illustrated on this page is made by the Continental Radio Corporation at Fort Wayne, Indiana. It uses nine tubes, seven of the 227 type, two 171-A, and one rectifier type 280. The set comprises six r. f. stages, and one a. f. push pull stage. The detector is of the untuned grid bias type. The set has an antenna compensating condenser adjustable for short, medium and long antenna. Total watts consumed 109. Plate voltage on the audio stage is 180 volts.

Analysis of Voltages

Using a Weston No. 537, type 2 radio set-tester, the following is a typical analysis of the voltages on the Slagle model 9.

First r. f. 227, tube out A voltage 2.45, B voltage 94, tube in tester A volt-

age 2.15, B voltage 80, C voltage 3, cathode volts positive 3, normal plate m. a. 4.5, plate m. a. grid test 7.

Second r. f. 227, tube out A voltage 2.45, B voltage 98, tube in tester A voltage 2.15, B voltage 88, C voltage 3, cathode volts positive 3, normal plate m. a. 5.8, plate m. a. grid test 8.8.

Third r. f. 227, tube out A voltage 2.45, B voltage 94, tube in tester A voltage 2.15, B voltage 80, C voltage 3, cathode volts positive 3, normal plate m. a. 3.8, plate m. a. grid test 6.1.

Fourth r. f. 227, tube out A voltage 2.45, B voltage 98, tube in tester A voltage 2.15, B voltage 88, C voltage 3, cathode volts positive 3, normal plate m. a. 5, plate m. a. grid test 8.

Fifth r. f. 227, tube out A voltage 2.45, B voltage 98, tube in tester A voltage 2.15, B voltage 80, C voltage 3, cathode volts positive 3, normal plate

m. a. 4.6, plate m. a. grid test 7.2.

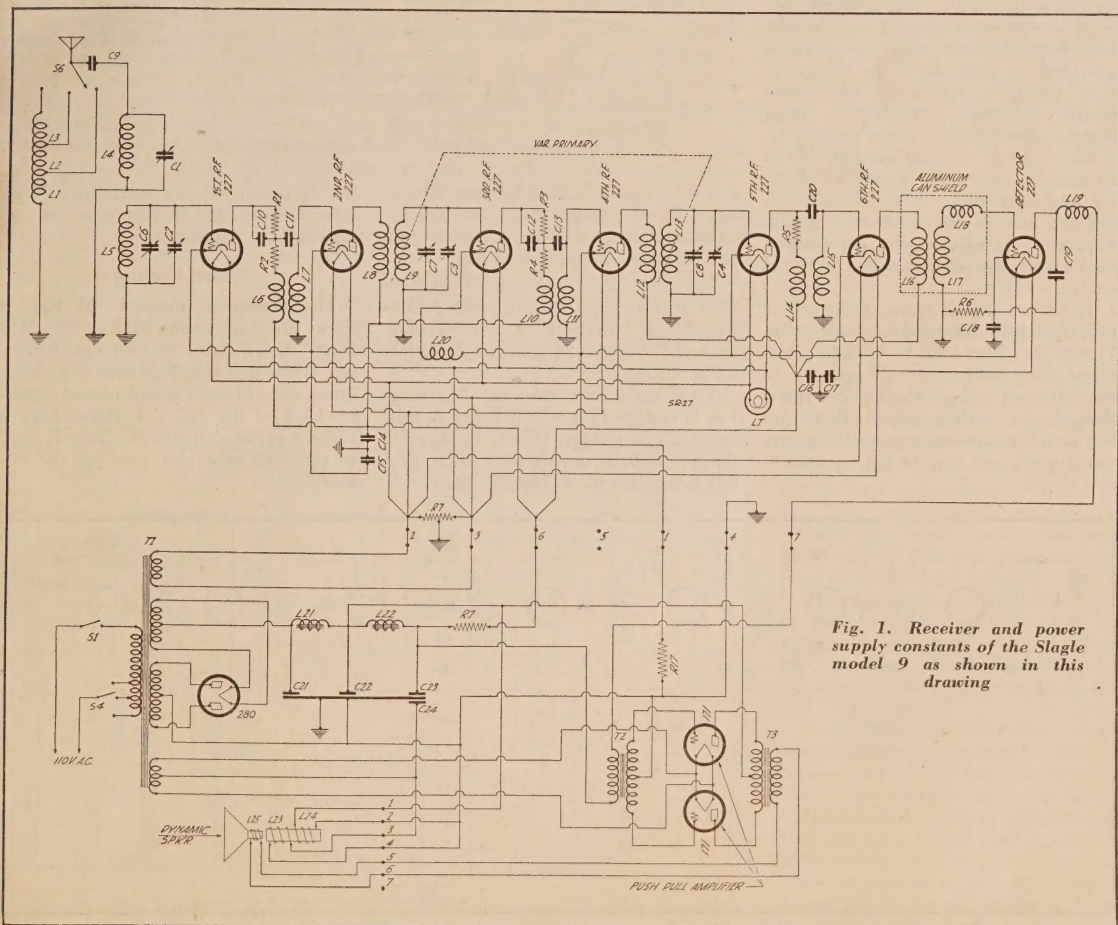
Sixth r. f. 227, tube out A voltage 2.45, B voltage 98, tube in tester A voltage 2.15, B voltage 90, C voltage 3, cathode volts positive 3, normal plate m. a. 4.5, plate m. a. grid test 7.2.

Detector 227, tube out A voltage 2.45, B voltage 192, tube in tester A voltage 2.15, B voltage 177, C voltage 20, cathode volts positive 20, normal plate m. a. 1, plate m. a. grid test 5.5.

Push Pull Readings Same

Readings of the push pull 171-A tubes are identical. With tube out A voltage 5, B voltage 192, tube in tester A voltage 4.9, B voltage 172, C voltage 37, normal plate m. a. 16.5, plate m. a. grid test 53.

Rectifier 280, tube out, A voltage 5.2, tube in tester A voltage 4.5, normal plate m. a. 45.



SHOWN schematically on this page is the Colonial Model 31 a. c. receiver and its power supply, manufactured by the Colonial Radio Corporation, Long Island City, N. Y.

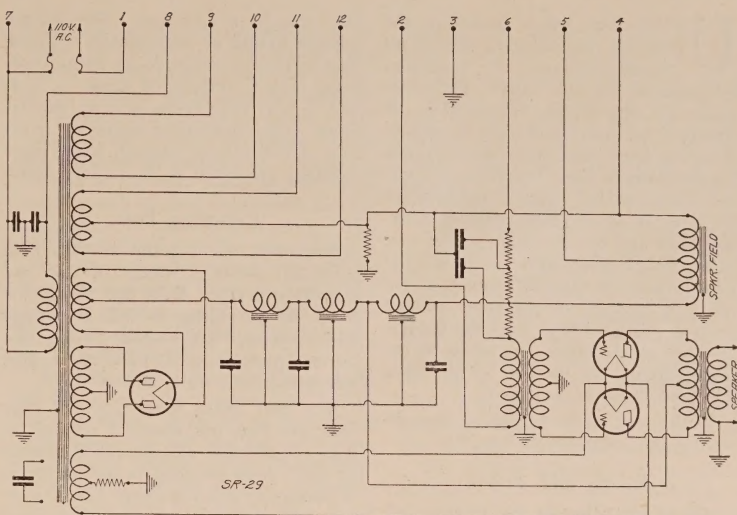
The schematic diagram of the power supply is shown in Figure 4, while the drawing of the receiver circuit itself is illustrated in Figure 5.

The first stage r. f. 226 tube should measure A voltage of 1.35, B voltage 95, C voltage 4.5, and normal plate m. a. 6. This value and the succeeding ones are those used when the tubes are in the set tester.

In the case of the 227 detector the A voltage is 2.15, B voltage 30, and the normal m. a. is 2.

The 227 used in the first audio stage has an A voltage of 2.15, B voltage of 80 and C voltage of 4.5. Its normal m. a. is 3.

Both of the 171-A's used in the push-pull stage read alike and the A voltage will be 4.5, B voltage 160, C voltage 38 and the normal m. a. should be 15.



With respect to the 280 rectifier A voltage should be 4.5, while the normal m. a. should be 42 per anode.

Possible defects and their accompanying symptoms which may occur:

Distorted output. Low plate voltage on first a. f. generally due to by-pass condenser (1475 p) or voltage divider (1478 p) both located in power units, right-hand side, under shelf near Merphon condenser. No plate voltage on detector. Possible ground in phono jack or open voltage divider. Sometimes this is also due to a ground oc-

curing in the system shunting the first a. f. transformer primary. No plate voltage in this stage is seldom due to a by-pass condenser (1475 p) or the a. f. transformer itself.

Modulator hum is often caused by a defect in the r. f. by-pass condenser (1476 p). In this case grid voltage on the r. f. tubes will be only about two or three volts, which should normally be five or six. It is seldom caused by the line buffers excepting some of the early models 31 which have no buffers.

In case the volume control works on one side only it generally indicates an open input primary or a broken connection in the same circuit.

Very loud hum and no grid voltage on the first and second r. f. and first a. f. may sometimes be caused by the cathode lead from the detector socket grounding on the sharp edge of right-hand bulwark in the chassis.

Ordinary hum is most often caused by an old or defective Merzhon condenser, or one from which the liquid has leaked out. Poor external ground or incorrect detector plate voltage may also be a cause.

Radio frequency oscillation may be due to incorrect adjustment of the balancing system. The balancing adjusters 9L-10L are situated inside the second and third r. f. primary coils and are held fast by a round head brass screw which moves in a slot, permitting the adjustment of the adjusters. If an accidental ground occurs in the r. f. grid returns oscillation will result.

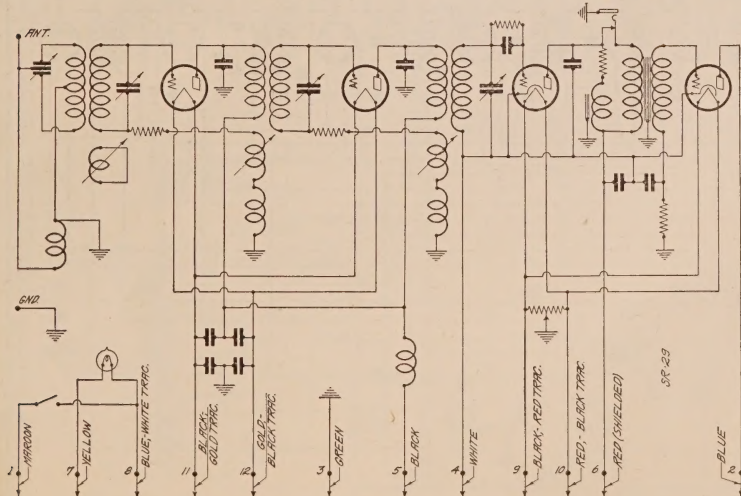


Fig. 5. This drawing is the schematic of the Model 31 Colonial receiver described on this page.

King Model J Set and Power Supply

FOUR 226 tubes, one 227, two 171-A's in push pull and a 280 rectifier comprise the tubes used in the King Model "J" and power supply, made by the King Manufacturing Corporation of Buffalo, New York.

According to the instructions provided by King for service men, each of the rotors in the gang condenser is adjusted on the gang at the factory. Under no circumstances should an attempt be made to re-set these rotors. Minimum adjusters are provided to make up for any minor difference in capacity due to wiring. The minimum adjusters are located on the front of the condenser gang and should be adjusted with a strip of flat bakelite slotted on the end to take the hexagonal head of the screw. When connected to an oscillator and output meter a peak should be obtained on each condenser with settings of 230 meters, 400 meters and 480 meters, by turning minimum adjustment screw. Of course, the peak will be much sharper on the lower setting. Failure to obtain a peak may either mean condenser rotors out of gang or coil butterflies out of adjustment.

The neutralizing condensers are located at the rear of the condenser bearing. If it is found necessary to reneutralize this set this may be accomplished in the regular way by using a tube with one filament prong cut off. In case the

rotors are in need of reganging or the plates are out of line, the entire gang should be sent to the factory for adjustment. Another gang may be installed.

The inductance of the r. f. coil is adjusted at the factory by means of the brass inductance adjuster or butterfly, in the end of the coil. These are set on an oscillograph so that every soil has exactly the same value of inductance. The butterfly is locked in the exact position with an especially strong cement. In case this cement is loosened, return the coil and shield assemblies to the factory for adjustment. Another assembly may be installed temporarily.

In connection with neutralizing of the set there are some troubles peculiar to the a. c. tubes. If the set is neutralized at a voltage of 100 and the set is then moved to a locality where the voltage is as high as 120 the set may be thrown into oscillation. This would show up as a loud hum which would blanket all reception. Therefore, be sure when neutralizing the set that the voltage tap on the power transformer is set at the correct line voltage being used. For neutralizing the tap switch should be set one point ahead of the actual line voltage. For instance, if the line shows 110 volt neutralization should be done with a tap switch set on 100 volts.

Voltages for the filament, plate and grid should read within limits as noted

below. Any deviation from this may mean that the transformer is wrong or that the drain of the set is wrong.

With a line voltage of 115 to 120 volt, 120 tap on pack, the 226 filament should read from 1.3 to 1.5; the 227 should read from 2.3 to 2.5, the 171 filament should read 4.8 to 5.2 and the 280 filament reads from 4.9 to 5.3.

Plate voltage on the r. f. stages should be between 115 and 135, while the plate voltage on the detector runs between 30 to 45 volt. Plate voltage on the first audio frequency will measure from 125 to 150. Plate voltages on the 171, measured plate to filament will be 160 to 185, while measured from plate to ground will be 185-210. R. f. grid bias should be from 6 to 7.5 and the 171 grid bias 30 to 40 volts.

The factory has noted in a number of cases where after the set has been in operation for a few hours trouble developed showing up as a distinct loss of volume. This apparently is due to a change in capacity of the detector circuit minimum adjusters due probably to a change in the tension of the spring brass used in this adjuster. As the tuning of this one circuit is especially sharp a small change of capacity affects the operation materially. All that it is necessary to do to correct this is to readjust this one minimum adjuster with a small open end wrench.

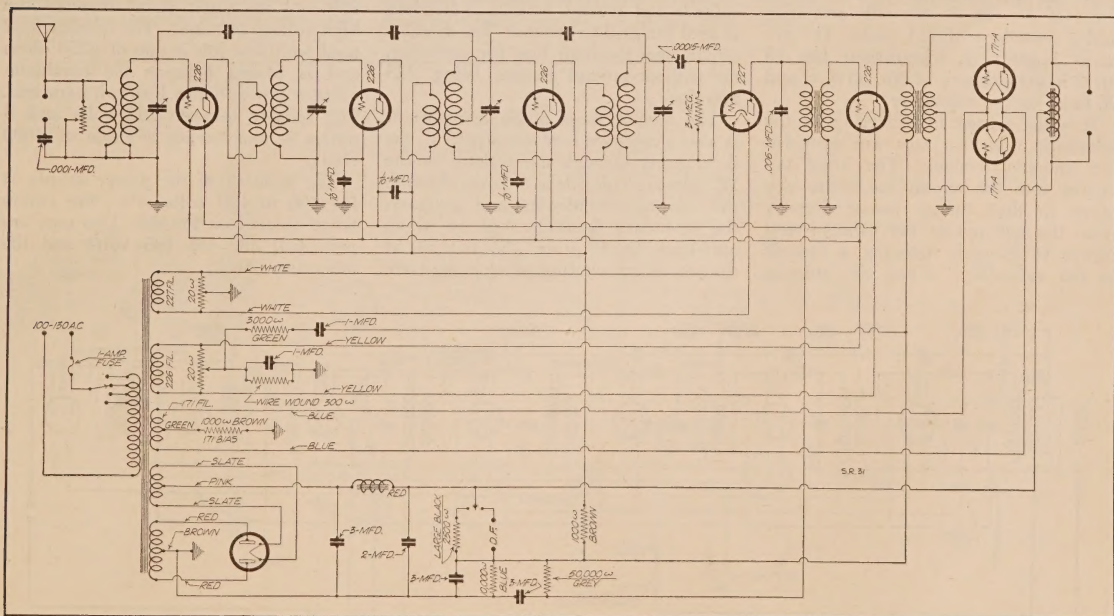


Fig. 7. The general layout of the circuit used in the King Model "J" receiver and power supply is set forth in the above schematic diagram

Gilfillan Bros. Model 100 Receiver

USING six 227 type tubes in the r. f. and first audio the schematic circuit of the Gilfillan Bros. model 100 receiver and its power supply is shown on this page. The output tube is a 245 while all of the r. f. stages, the detector and the first audio employ the 227. The diagram of the receiver is shown in the schematic Figure 9 while the power supply is illustrated in Figure 8. A 280 rectifier is used for the high voltage.

Looking at the schematic of the receiver shown in Figure 9 it is observed that the four radio frequency stages use the stabilizing resistances in the grids of the 227 tubes. These values are shown as 800 ohms. The first 227 used as an antenna stage has a trimmer across the tuning condenser to compensate for various antenna loads. It will also be noticed that from the primary of the first r. f. transformer to the plate of the first 227 is placed a midjet capacity. Between the plate of the first and second 227 is another midjet capacity while between the plate of the second and third is another capacity and the same applies to the coupling between the plate of the third and the fourth tubes. The condensers previously mentioned are used for phase balancing, one of the several methods of neutralization.

All the r. f. transformers have twelve turns of No. 36 double silk primaries and a secondary of 114 turns. The antenna input r. f. transformer has 15 turns in the primary of No. 36 d. s. and 96 turns on the secondary.

It will be seen by referring to the schematic that two taps are provided for antenna control. The long tap throws into the circuit the entire primary so that energy comes directly from the antenna to the primary and thence to ground, inducing a voltage in the secondary. When the antenna

switches on the short side, it throws the aerial in on a tap 30 turns down from the top of the secondary inductance. As previously stated the trimmer across the first section of the tuning condenser serves to balance up the antenna stage so that it will be in line with succeeding radio frequency stages.

Volume control used on the set is a 10,000 ohm variable in series with a 450 ohm fixed resistance between the common cathode line and the ground.

The plate circuit of the 227 detector has the usual r. f. choke in series with it and is bypassed by a .002 mfd condenser. The coupling to the first audio is a combined resistance and capacity method. The resistor in the plate circuit of the 227 is a .1 megohm while the coupling capacity is a .1 mfd condenser. Bias on the 227 in the first

mon with the top of the primary winding so that the return is from the grid of the 245 through the secondary, through the plate and thence to ground.

Plate voltage for the first, second, third, fourth radio frequency stages and the detector as well as the first audio should be 140 volts from the power supply. The output tube secures 250 or 300 volts. All of the tubes secure their filament current from the 2.5 volt winding.

In the schematic diagram Figure 8 which covers the power supply a 280 is used as the rectifier. A hum control resistance of 10 ohms is placed across the two and a half volt filament secondary. A 1500 ohm resistance between B minus and the center of the hum control resistor serves to provide the bias for the 245 tube. A 30 ohm re-

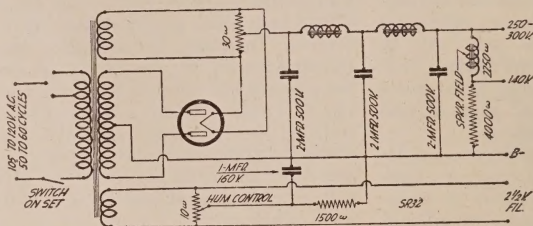


Fig. 8. The schematic of the power pack used with the model 100 Gilfillan receiver is shown in this diagram

audio stage is secured by the drop across the 1500 ohm resistance between cathode and ground, while a .5 megohm is used for grid to ground. The detector circuit uses the high bias for detection, the cathode-ground resistor being .025 megohm.

The second stage audio transformer is also a resistive load arrangement, the d. c. going through the resistor in the 227 plate circuit, the a. c. going through the coupling condenser and primary, the secondary being hooked up in an auto-transformer style, the bottom of the secondary winding being made com-

sistance is placed across the low voltage secondary for the filament of the 280 and its center point becomes the high voltage terminal. The speaker field used with this job is one of 2250 ohms and is placed between the maximum voltage tap and the 140 volt terminal. The resistor between 140 volts and B minus is one having a value of 4000 ohms.

The primary of the power supply is for 105 to 120 volts a. c., the switch being located on the set. Two taps are provided, one for 105 volts and the other for 120.

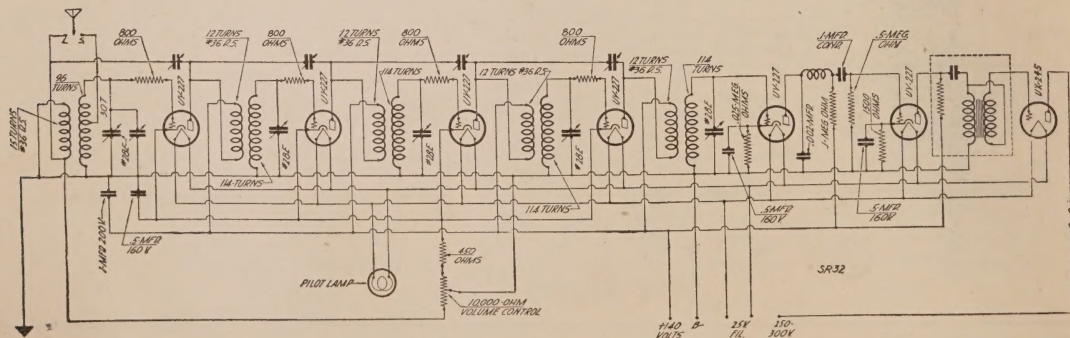


Fig. 9. In this drawing are shown the constants of the model 100 Gilfillan receiver described on this page

Erla Duo-Concerto Model Receiver

MANUFACTURED by the Electrical Research Laboratories of Chicago, Illinois, the Erla Duo-Concerto model receiver is shown schematically on this page. The receiver portion which is known as model R2 is illustrated in Figure 10, while the audio amplifier and power supply units known as model A2 is set forth in drawing, Figure 11.

As will be seen in the schematic of the receiver there are three radio frequency stages using 226 tubes and a detector using a 227 heater type. The radio frequency condensers are all on a gang and the three r. f. stages are neutralized. Input to the antenna stage is across a 10,000 ohm potentiometer in parallel with the primary winding of the first r. f. transformer.

The second stage audio and the two 171-A tubes in push pull are located within the power unit as shown in the drawing Figure 11. A 280 rectifier is employed for the high voltage, while filament current for all tubes is supplied from the necessary low voltage windings on the power transformer.

The complete outfit consists of a chassis R2 carrying the radio frequency, an audio amplifier A2 and its power supply, and a dynamic speaker type D. The job is made up in two forms, one for use in connection with a loop antenna, the other with the regular outside or inside antenna.

Looking at the radio frequency chassis from the front it will be seen that

there are three balancing hex nuts and three neutralizing hex nuts. Beginning at the right the first nut is neutralizer 1, then balancing, then neutralizing two, then balancing, then neutralizing three, and finally the balancing for the third r. f. The order of tubes reading from the right towards the left is first r. f., second r. f., third r. f., and then detector at the extreme left. To balance the receiver tune in sharply a distant station with low volume between 240 and 280 meters. Then with a balance-

ancing wrench turn the nut N3 (located in line with the tube sockets) left or right until a null or minimum volume position is found. Replace regular tube in its socket. This stage is neutralized. Proceed in the same manner on the second stage, adjusting nut N2 and first stage adjusting nut N1.

According to instructions from the factory the outside or indoor antenna used in connection with this receiver should never exceed 50 feet in length.

In the rear of the radio unit are two

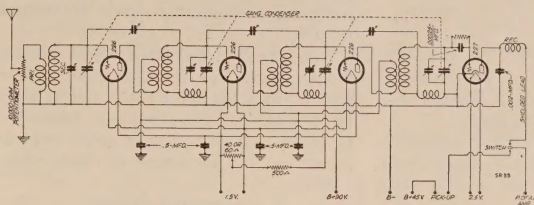


Fig. 10. The receiver portion of the Erla Model described on this page is shown in the above schematic diagram. The audio and power supply end of the receiver is contained in another unit and is illustrated schematically in Fig. 11

ing wrench obtainable from the maker of the receiver turn the balancing nut B previously mentioned for maximum volume.

For neutralizing the receiver in the event this is necessary, a neutralizing tube is required. This tube is a good 226 with one filament prong sawed off. Tune in sharply a local station between 240 and 280 meters, then remove the third r. f. tube and insert the neutralizing tube, retuning the receiver for maximum volume. Then with a special bal-

tip jacks for connecting an electrical pick-up unit. It is merely necessary to place the two phone tips in those jacks. As will be seen in the schematic diagram Figure 10 at the lower right hand corner, arrangement has been made for a switch whereby the listener may turn the receiver from a radio to a phonograph combination.

In the absence of any actual measurement of tube voltages on this model we are not able to supply this information.

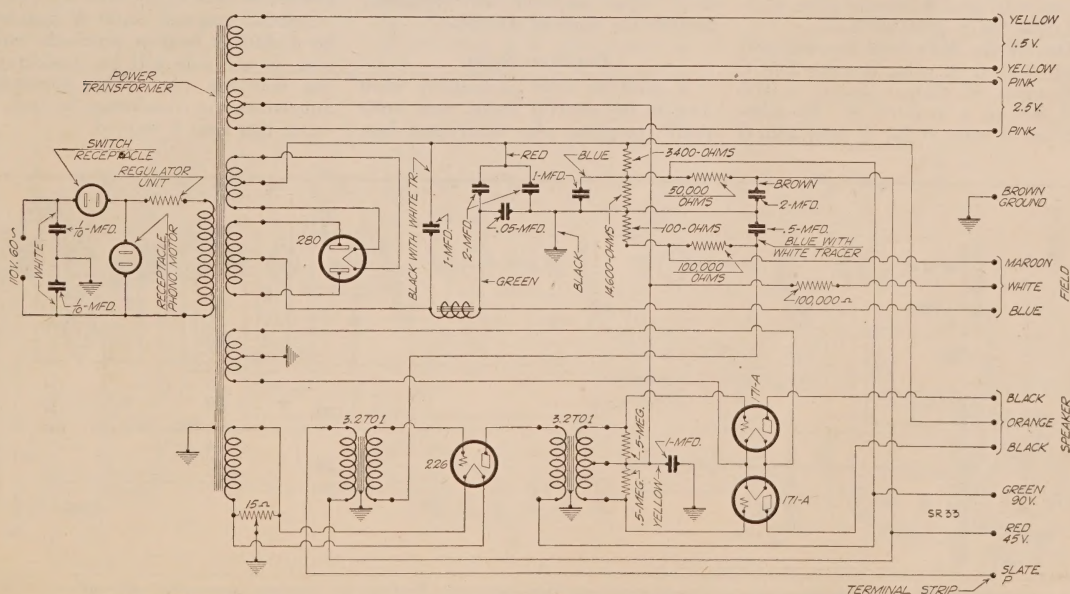


Fig. 11. Electrical constants of the power supply and audio amplifier used on the Erla model are shown above

THE balanced bridge type of circuit is used in the 900 series a. c. radio receiver made by Stewart Warner and shown schematically on this page. This circuit differs from the usual circuit of its kind in that it makes use of shunt capacity through separate choke coils and bypass condensers, thus separating all radio frequency from the power circuit which makes for greater stability, allowing amplification to be carried to a further point without oscillation. The complete circuit diagram is shown in Figure 12.

An analysis of voltages on the series 900 receiver made with a Weston 547 test set shows the following:

First r. f. 227 A volts 2.2, B volts 145, C volts minus 10, cathode heater volts plus 10, normal plate m. a. 3.7, plate m. a. grid test 6.7.

The second r. f. 227 shows A volts 22, B volts 145, C volts minus 10, cathode volts plus 10, normal plate m. a. 4.7 and plate m. a. grid test 8.

The third r. f. 227 shows A volts 2.2, B volts 147, C volts minus 10, cathode volts plus 10, normal plate m. a. 3.9 and plate m. a. grid test 7.1.

The detector 227 reads 2.2 A volts, B volts 30, C volts 0, cathode heater volts 0, normal plate m. a. 1.8 and plate m. a. grid test 2.

The first a. f. 227 has A volts 2.2, B volts 140, C volts minus 8, cathode heater volts plus 8, normal plate m. a. 4.5, plate m. a. grid test 5.7.

One of the 245's used in push pull reads 2.2 for A volts, B volts 235, C volts minus 43, normal plate m. a. 27.5 and plate m. a. grid test 30. The other 245 has A volts of 2.2, B volts 235, C

volts minus 44, normal plate m. a. 32
and plate m. a. grid test 35.

The 280 rectifier reads A volts 4.6, normal plate m. a. 47.5. These readings are taken with the volume control full on and a line voltage of 109.

It is to be noted that a certain amount of variation is to be expected in tube readings. Experience coupled with a knowledge of the circuit of the set should tell whether the variation found with any particular receiver is normal or not.

The standard test with a suitable radio set tester will indicate more or less closely in what circuit the defect may be found. It then becomes necessary to make a series of continuity tests to locate exactly the source of the trouble.

Noisy operation is usually due to outside disturbances picked up by the aerial system. To determine its source disconnect both aerial and ground. If the noise continues it is evidently in the set. It may be necessary to turn back the volume control of the receiver and set the dial for a fairly high wavelength station to prevent oscillation without the ground.

A loose connection anywhere in the entire receiving system will cause a noise. It is necessary to check all possible points. Jarring or shaking the items under suspicion will frequently indicate the cause of the noise.

A defective tube particularly when used in the detector socket may cause noisy reception. An interrupted buz-

zing that continues with the aerial and ground disconnected is almost certain to be caused by the detector tube.

Excessive hum may be caused by a defect in the receiver, the tubes or the power circuit. Most likely source of hum in the set itself is an open or short circuited resistor, particularly of the center tap kind. Check all resistors and fixed condensers particularly those used for bypassing r. f. current.

Poor tone quality may often be caused by a defective tube, this being more noticeable when the volume is increased. Low voltage, either low filament or plate voltage will cause scratchy reception. Incorrect C bias may also be the cause of poor tone quality. Check all grid bias resistors, make certain their resistances are correct and that they are not short-circuiting anywhere. Check grid voltage.

Occasionally mechanical vibration of the power transformer cover will result in a decided hum. This can be checked easily by pulling out the speaker plug while the set is in operation. If the hum continues it is almost certainly vibration of the transformer cover. To eliminate it remove the cover, pry off its lid and pull outward on all four sides to give the cover a noticeable barrel shape. Force the lid on again and replace the cover.

Another frequent cause of hum will be a rectifier tube in which the emission on one side will be considerably less than the other. This apparently unbalances the transformer to such an extent that hum is secured.

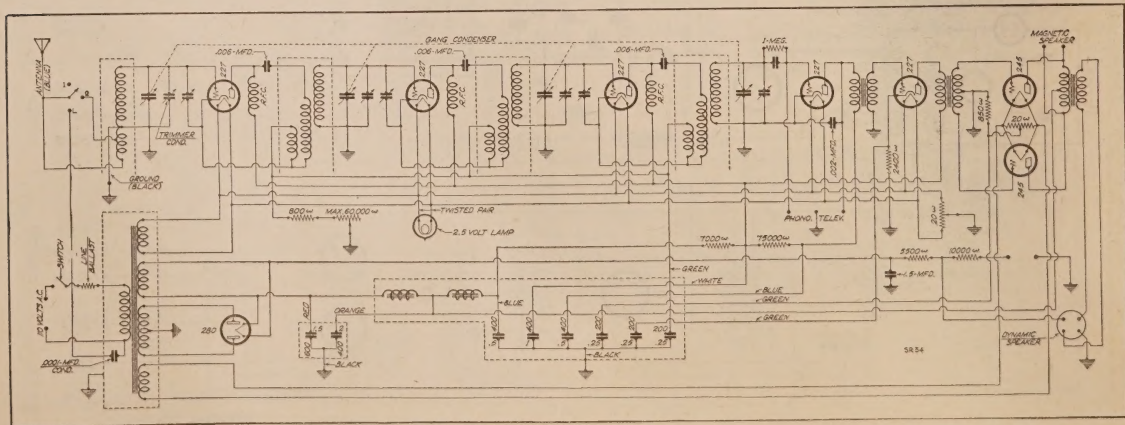


Fig. 12. The electrical circuit of the Stewart Warner series 900 receiver described here is shown in the above schematic

Silver Model 30 Receiver and Pack

FOUR screen grid 224 tubes, one 227, two 245's and a 280 rectifier are used in the Silver Model 30 receiver described on this page. The schematic diagram of the receiver and its power supply is shown in Figure 13.

Measurements made on two stock Silver chassis with a Jewell 199 Analyzer are given below and indicate normal variations which may be encountered due to the varying tubes and line voltages. Variations within the limits shown or even slightly beyond are no indication of trouble unless some other operating fault is seen.

On one set with a line voltage at 117 and the volume control at maximum the first r. f. 224 showed a shield voltage of 64, A voltage of 2.45, B voltage 152, C voltage 1.5, cathode voltage 1.7 and normal plate m. a. of 4.5.

The second r. f. 224 showed a shield voltage of 64, A voltage of 2.47, B voltage 145, C voltage 2, cathode voltage 2, and normal plate m. a. 3.6.

Third r. f. 224 shield voltage 64, A voltage 2.48, B voltage 148, C voltage 2, cathode voltage 2, and normal plate m. a. 3.3.

Detector 224 showed shield voltage 72, A voltage 2.51, B voltage 68, C voltage 6, cathode voltage 5, and normal plate m. a. 1.

The first a. f. 227 showed an A voltage of 2.51, B voltage 184, C voltage 1, cathode voltage 13 and normal plate m. a. 7.

In the case of the push pull 245 there was a difference of 9 mils between one tube and another. For example, the first tube showed A voltage of 2.49, B volt-

age 223, C voltage 44 and normal plate m. a. 21. The second 245 showed A voltage of 2.49, B voltage 220, C voltage 43.5 and normal plate m. a. 32. This unbalance in the 245 while not desirable did not seriously affect the operation of these two sets.

The second set was tested with a line voltage of 117, volume control at maximum and showed:

First r. f. 224, shield voltage 71, A voltage 2.45, B voltage 170, C voltage 1, cathode voltage 1, and normal plate m. a. 2.8.

Second r. f. 224, shield voltage 71, A voltage 2.48, B voltage 161, C voltage 2, cathode voltage 1.7, and normal plate m. a. 3.1.

Third r. f. 224 showed shield voltage of 70, A voltage 2.48, B voltage 164, C voltage 2, cathode voltage 2, and normal plate m. a. 3.

Detector 224 showed shield voltage of 69, A voltage 2.5, B voltage 76, C voltage 7, cathode voltage 7, and normal plate m. a. 1.

The first a. f. showed a voltage 2.49, B voltage 196, C voltage 1, cathode voltage 14, and normal plate m. a. 7.8.

One of the 245's in the push-pull stage showed A voltage 2.45, V voltage 222, C voltage 44 and normal plate m. a. 32. The other showed A voltage of 2.45, B voltage 224, C voltage 44, and normal plate m. a. 22.

The above readings do not apply to receivers equipped with the external type 30 filter units or to receivers bearing serial numbers above 12,907. In the case of such receivers an additional 10 volt drop in B voltage must be al-

lowed for across the type 339 U choke coil known as L12.

In general, if no voltage is obtained in any measurement with the analyzer, the receiver should be removed from its cabinet and the particular circuit at which no voltage is apparent checked through, using the set analyzer with its test leads. For example, if the first r. f. tube showed no plate voltage, its circuit should be checked through winding of coil L-2, through one winding of the coupling coil L-3, through the choke coil L-7, and through the red-white connecting wire, to the common join of resistors R-9, R-10, and R-11 (mounted on a panel behind the On-Off switch). If no screen potential was observed upon the third r. f. tube, for example, it would be necessary to check the screen circuit through the resistor R-6 and through the slate cable lead to the arm of the potentiometer P-1 and then through to the joint between the green resistor R-9 and P-1 (and so on).

Again, should no grid bias be observed (read as "cathode volts" on the set analyzer) on the first audio tube, S-5, the circuit should be checked through by disconnecting the lead from the condenser bank (to check for a possible short-circuited condensed) and again determining if voltage appeared across the white resistor R-8. Should it fail to appear, the cathode might be directly grounded (possibly by contact between both ends of the resistor and the shielding), or no plate current might be being drawn, which would indicate an open plate circuit, which in turn, would be checked obviously.

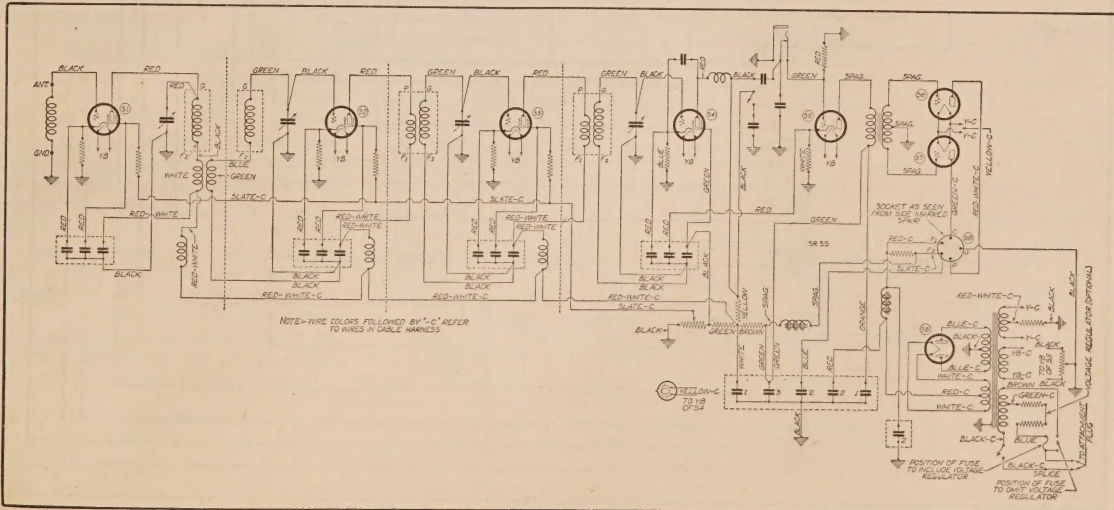


Fig. 13. Schematic diagram of the radio receiver and its power supply is shown in the above illustration. This is the model 30 Silver

The Splidorf E175 Receiver and Pack

MADE by the Splidorf Radio Corporation of Newark, New Jersey, the type E175 receiver and power supply is illustrated below. Schematically the receiver and the high voltage supply are shown in Figure 14.

Examination of the schematic circuit will indicate that the antenna stage has three taps on the primary for different antenna lengths. The second radio frequency and third radio frequency stages have a grid suppressor resistance in series between the coil and the grid. No grid resistor is used on the first r. f. stage. Detection in the case of the receiver here described is by means of the grid condenser and grid leak. The secondary of the first audio transformer has a resistor placed across its extremities which is used to flatten out the response curve of that particular transformer.

The detector used in this receiver is a 227, while all of the remaining tubes in the r. f. and first a. f. stages are of the 226 type. The resistance R-6 in Figure 14 is placed across the 226 filament line and is by-passed both ways from the center with condensers C-8 and C-9. Resistor R-8 supplies the required

bias for the 226 grids. In the case of the 227 detector a resistance R-7 is placed across the filament line and the center tap of this resistor is made common with the cathode. The cathode is also at ground potential as are all of the grid returns on the radio frequency stages as well as the first and second audio.

Primary Fused

A switch is provided in the primary circuit of the power transformer together with a fuse and a fixed resistance R-10. The high voltage secondary S-4 goes to the plates of the 280 rectifier, while the filament current for the rectifier is supplied by the secondary S-3. The center tap of S-3 becomes the high voltage terminal of the system in conjunction with the choke coils X-1 and X-2 and the voltage divider resistance R-11. S-2 furnishes the filament current for the 226 tubes while S-1 furnishes the current for the 227 detector. S-5 furnishes current for the output tube. Condensers C-10 and C-11 are arranged around the input and output of the choke X-1. The voltage divider resistor is made up into four sections, A

from the maximum voltage to the voltage for the plates of the 226's, B for the voltage applied to the detector, and C the resistor between the detector voltage and negative. Resistance D is the bias resistor for the power output stage.

The speaker is cut in through a condenser C-14 between the plate of the output stage and the center tap of the filament winding for that particular filament circuit.

It will be observed that the resistance R-4 is placed across the extremities of the primary in the fourth radio frequency transformer. The arm of this variable resistance is common with one side of switch SW-1 and the bottom side of by-pass capacity C-7, this variable resistor serving to give a resistance and capacity coupling between the plate of the third 226 and the plate of the 227 detector.

The hum control for the first audio 226 is resistance R-9 across the secondary S-2 of the power pack. Its center tap is common with the center tap of resistance R-6.

In the absence of any analysis of voltages for this particular model this information cannot be given.

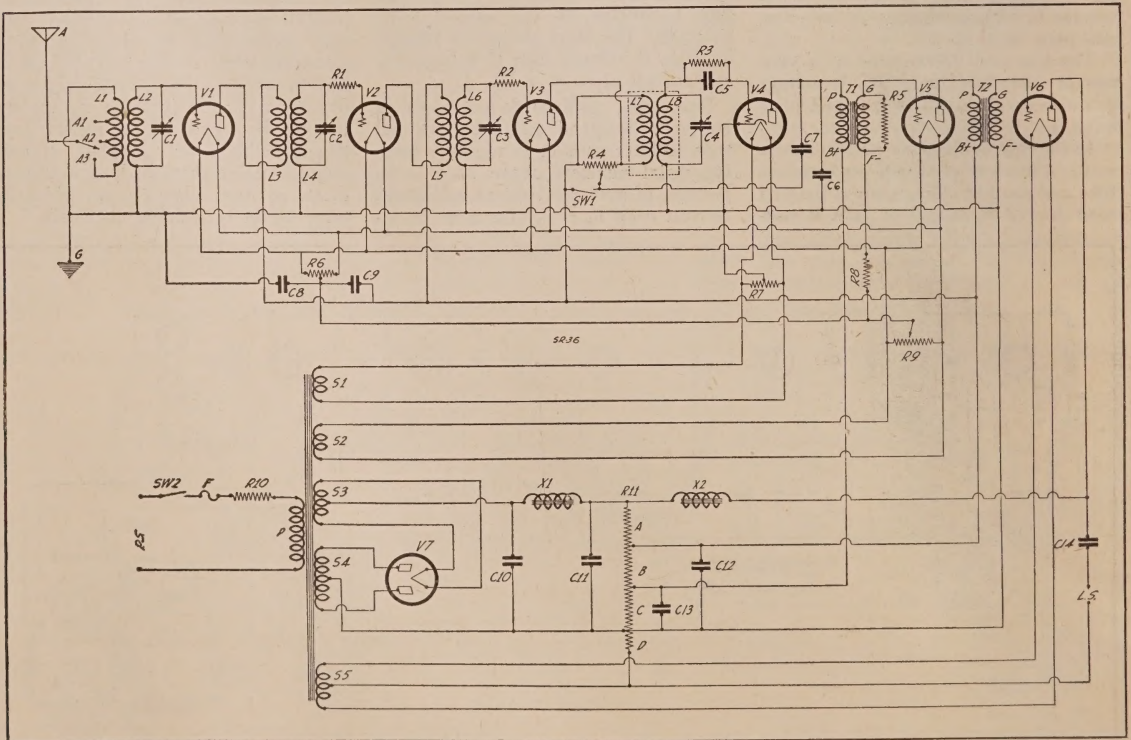
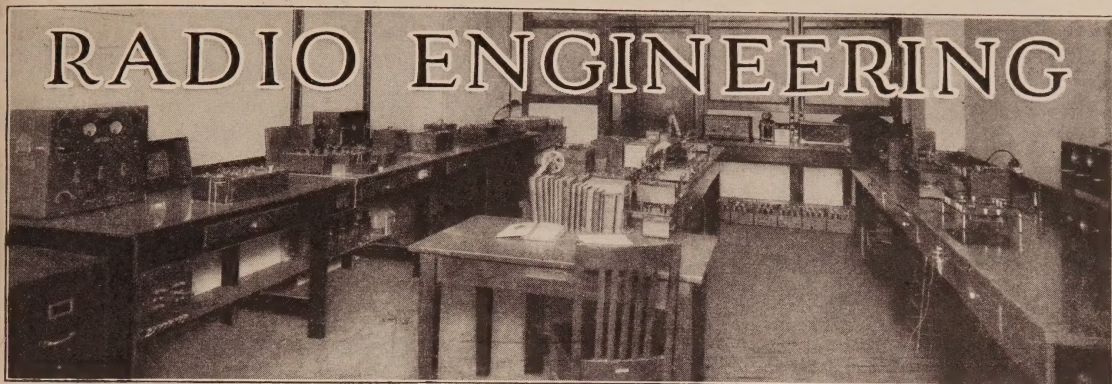


Fig. 14. All details of the receiver and power supply for the Splidorf E175 shown on this page is contained in the schematic drawing above



Engineering Show Might Take Place of Annual Consumer Show

Many Engineers and Executives Queried as to Opinions Concerning Advisability of a Change

BELIEVING there is room in the industry for the holding of an engineering show dedicated exclusively to the exhibition of component parts and accessories making up the factory built sets, instead of having a public show which apparently is not proving as valuable as might be desired to the manufacturers, this magazine addressed a questionnaire to a large number of engineers and executives in the industry to ascertain their reactions toward the idea of holding such an engineering show.

Response Gratifying

The response was very gratifying from the number of replies received, the varied comments made by the engineers and the apparent interest with which this suggestion was received. As soon as a complete tabulation has been made of all replies and comments, the material will be turned over to the Radio Manufacturers Association by this magazine with a request that they give consideration to the statements appearing in these questionnaires and determine whether such an engineering meeting would fit in with the policy of the Radio Manufacturers Association.

The Letter

The letter which was addressed to chief engineers and executives read:—

"We believe only two radio shows are needed by the industry. These are:

An Engineering show where all parts suppliers may exhibit products for the

exclusive benefit of engineers. A Trade show where dealers and jobbers may see working models of sets and arrange their buying schedule.

By holding the Engineering show sufficiently in advance of the Trade Show, engineers and parts supplies will have ample time to produce satisfactory models for the Trade show.

An orderly arrangement of an Engineering show followed by a Trade exhibition in June will serve to unkink the industry's annual sales curve, reduce overproduction, curb price cutting, eliminate double expense in the consumer shows, and put design, production and sale of radio apparatus on an intelligent, systematic and profitable basis.

We wish an expression from engineers on three points:

When is the most logical time for an Engineering show? _____

Where should it be held? _____

Under whose auspices? _____

We will be glad to have your view on this matter. A return envelope is enclosed for your convenience."

Engineers' Comments

In addition to the routine answers indicating personal preference on the part of the engineers, several engineers and executives have added comments, which we are printing because they indicate interesting angles on this subject.

Caxton Brown, vice president and secretary, Weston Electrical Instrument Corp., Newark, N. J.: "We are in fa-

vor of limiting to two radio shows; one to be an engineering and the other a trade show. In our opinion, however, it is difficult to believe that the engineering fraternity will have their developments ready to present much before June of any one year and of course it would be desirable to have the trade show some time before the early fall. We presume that the ideal arrangement would be, if possible, to have the engineering show in March and the trade show in June."

John H. Miller, electrical engineer, Jewell Electrical Instrument Co., Chicago, Ill.: "As we do not make radio sets we are not very much concerned. The trade show seems to serve our purpose best, as we are able to keep in touch with the parts suppliers fairly well from these shows. The writer does not believe that an engineering show would be of any great service, at least, as far as we are concerned, as we are fairly self-contained and use only basic products made outside."

E. N. Rauland, president, The Rauland Corp., Chicago, Ill.: "I do not believe that an Engineering Show or any other show would be successful unless it was held under the auspices of the Radio Manufacturers Association. As you probably know, the RMA have conducted three trade shows which have been highly successful, and with a great deal of benefit to the exhibitors and the industry in general. I do not believe that an engineering show as such is feasible, inasmuch as development

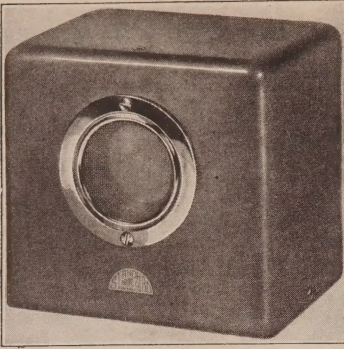


Fig. 1. This is a photograph of one of the condenser microphones made by the Standard Radio Co. of Chicago

among the manufacturers now is practically continuous throughout the year. It is not logical to believe that the manufacturers would withhold development of engineered models until they had the opportunity of seeing component parts or supplies exhibited at an engineering show. I strongly favor parts manufacturers and other suppliers of radio manufacturers to exhibit at the annual trade show of the RMA and at that time show their wares to the radio industry in general."

A. Hauser, chief engineer, Brown & Caine, Chicago, Ill.: "We do not seem to believe that an engineering show is actually possible with the exclusion of a trade show. A trade show is merely an exhibition of engineering developments. Should it be possible that engineers display an exhibit, their developments to one another, it should be held at the engineering societies like A. I. E. E. or I. R. E. similar to the standard meetings held by such societies. The question referring to the auspices under which such a show should be held is rather hard to decide and the writer at this time cannot give you information, as the first paragraph of this letter explains this. He would be very glad to hear from you as to what you are planning to do and upon receipt of more detailed information he will be able to form a better opinion."

E. E. Horine, chief engineer, National Carbon Co., New York City: "We are constantly being informed by parts makers of the merits of their products and of new developments just around the corner. It is doubtful if a show of the kind here proposed would add to this information, or in any way be of benefit to us in engineering new receiver developments."

R. W. Cotton, Samson Electric Co., Canton, Mass.: "I see very little purpose to be served by an engineer's show."

In addition to filling in the regular questionnaire indicating their choices in

the matter, the following engineers gave added suggestions which may be of interest:

E. K. Oxner, chief engineer, High Frequency Laboratories, Chicago: "I believe that an engineering show should be held in January on the assumption that trade shows will continue to be held in June or possibly May. The location of such a show will, of course, have to be a subject based on the choice of the majority and quite naturally we feel that Chicago would be most beneficial to the majority of set manufacturers. It is very difficult, indeed, to form an opinion as to what branch of the industry should hold such a show, although it would appear to devolve on the parts manufacturers themselves. This subject is a somewhat difficult one and I am not so sure that the idea of (Continued on page 130)

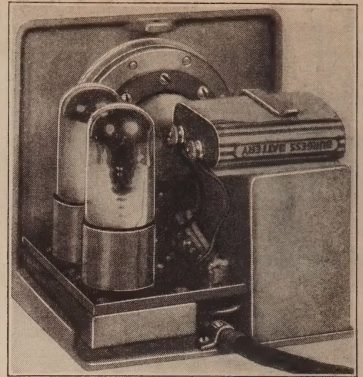


Fig. 2. This is a view of the inside of the condenser microphone illustrated in Figure 1 and is of the direct coupled type, the A and B supply being self contained

Rochester I. R. E. Convention

ONE of the most interesting of the engineer meetings held this year was the Eastern Great Lakes District Convention of the Institute of Radio Engineers at the Sagamore Hotel in Rochester, New York, November 18-19. Attendance at the meeting exceeded the expectations of those in charge and it is understood there were in excess of 200 at this convention.

Credit to Graham

A great deal of the credit for such a successful convention is due to the activity of Virgil M. Graham, executive

chairman at Rochester, who was assisted by L. Grant Hector, vice-chairman, from Buffalo; and A. R. Barfield, secretary and H. J. Klumb, treasurer, both from Rochester.

The publicity committee was headed by R. A. Hackbusch, chairman from Toronto, with K. L. Henderson, vice-chairman of Buffalo, and E. C. Karker, and I. G. Maloff of Rochester, and D. Schregardus from Cleveland.

Other committees operating in conjunction with the executive chairman were:

Finance

H. J. Klumb, Chairman, H. A. Brown, H. E. Gordon, E. A. Hanover, A. T. Haugh, and I. G. Maloff.

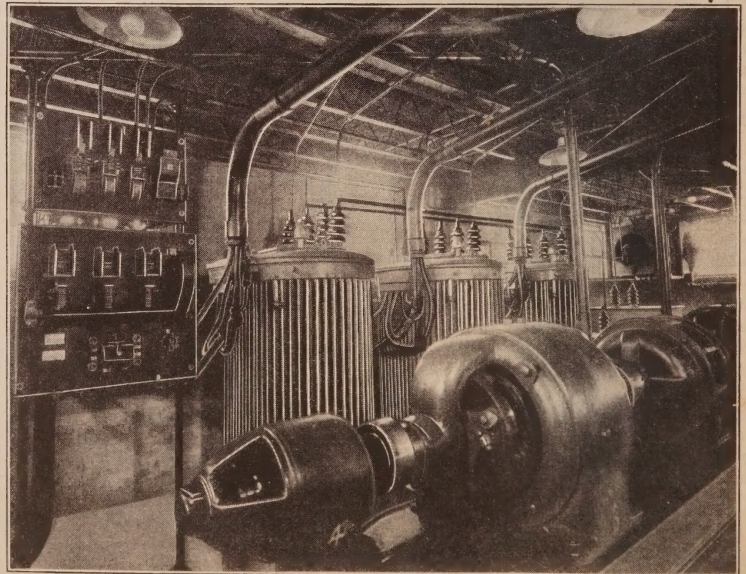


Fig. 3. Transmission engineers may be interested in this photograph of the power plant of Station WOWO at Ft. Wayne, Indiana, which has recently been completed by the owners under the supervision of a Chicago transmission engineer

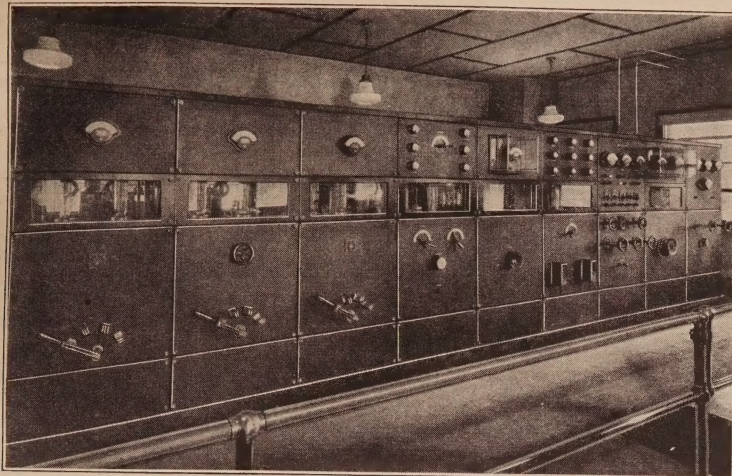


Fig. 4. In this photograph may be seen the complete control panel of Station WOWO at Ft. Wayne, a brief description of which appears elsewhere in this section

Technical Papers

Virgil M. Graham, Rochester.

Transportation and Accommodation

J. Eichman, Chairman, Buffalo; J. M. Leslie, Toronto; J. R. Martin, Cleveland; and A. E. Soderholm, Rochester.

Fellowship

H. E. Gordon, Chairman, Rochester; F. A. Lidbury, Buffalo; and C. L. Richardson, Toronto.

Trips

A. L. Schoen, Chairman, Rochester and A. E. Soderholm, Rochester.

Entertainment and Reception

E. C. Karker, Chairman, Rochester and Howard Brown, Rochester.

Ladies' Entertainment

Mrs. O. L. Angevine, Chairman, Mrs. C. S. Barrows, Mrs. H. A. Brown, Mrs. H. E. Gordon, Mrs. V. M. Graham, Mrs. E. A. Hanover, Mrs. E. C. Karker, Mrs. H. J. Klumb, Miss Marie Maeder, Mrs. R. H. Manson, Mrs. V. M. Palmer, Mrs. A. L. Schoen and Mrs. A. E. Soderholm.

Exhibits

I. G. Maloff, Chairman, Rochester.

Registration

A. E. Soderholm, Chairman, Rochester; O. L. Angevine, Registration Secretary (Executive Secretary of Rochester Engineering Society), E. C. Karker, Rochester; Bruce W. David, Cleveland; L. Grant Hector, Buffalo; V. G. Smith, Toronto; Miss Marie Maeder, Rochester and Miss Viola Hanley, Rochester.

Program

The program for the meeting follows:

MONDAY, November 18

8:00 a.m. Registration at Convention Headquarters, Sagamore Hotel.

10:00 a.m. Opening Technical Session. "Welcome," by Earl C. Karker, Chairman of Rochester Section.

"What Executives Expect of Engineers," by I. G. Maloff, Valley Appliances, Inc.

"Consideration in Screen-Grid Receiver Design," by W. A. MacDonald, Hazeltine Corporation, read by D. E. Hartnett.

12:30 p.m. Adjournment for luncheon.

2:00 p.m. Inspection trip to Kodak Park and Valley Appliances, Inc.

8:00 p.m. Technical Session.

"Ultra High-Frequency Transmission and Reception," by A. Hoyt Taylor, Naval Research Laboratory.

"Television With Cathode Ray Tube for Receiver," by Dr. V. Zworykin, Westinghouse Electric and Manufacturing Co.

TUESDAY, November 19

9:30 a.m. Technical Session.

"A Broadcast Receiver for Use in Automobiles," by Paul O. Farnham, Radio Frequency Laboratories.

"Standardization in the Radio Vacuum-Tube Field," by W. C. White, General Electric Research Laboratory.

"New Developments in Direct Coupled Amplifiers," by E. H. Loftin and S. Y. White, read by S. Y. White.

12:30 p.m. Joint Luncheon with Rochester Engineering Society.

Speaker—W. Roy McCanne, President of Stromberg-Carlson Telephone Manufacturing Company.

2:00 p.m. Inspection Trip to Stromberg-Carlson Plant.

6:30 p.m. Banquet—A. T. Haugh, Toastmaster.

Speaker—H. B. Richmond, President of Radio Manufacturers' Association. Subject—"The Engineer in the Radio Industry."

WOWO Transmitter

TRANSMISSION engineers may be interested in the photographs and a brief description of the 50,000 watt broadcast transmitter built for WOWO at Ft. Wayne which is now operating on 10,000 watts, in accord-

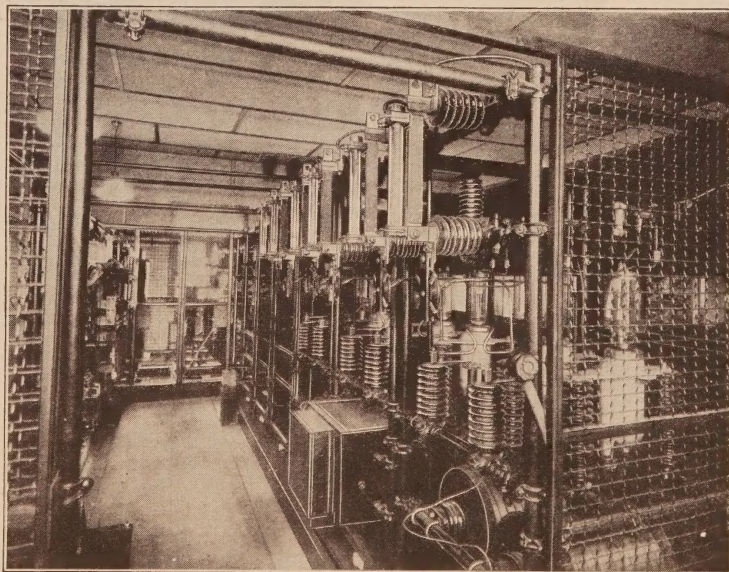


Fig. 5. This photograph shows the rear of the control panel illustrated in Figure 4. A description of the parts is given elsewhere in this article

ance with authorization by the Federal Radio Company.

The transmitter was designed, constructed, installed and supervised by a firm of Chicago radio transmission engineers, E. A. Beane Engineers.

A photograph of the control panel is shown in Figure 4, while Figure 5 shows rear of this set of panels. Figure 3 is an illustration of the power plant for this particular transmitter.

Control Apparatus

In Figure 4 may be seen the nine individual panels which are placed together forming the entire control apparatus. Beginning at the left and reading towards the right, the first, second and third panels are for the first, second and third phases of the rectifier. The fourth control panel is the crystal control, the fifth the modulator, the sixth a 500-watt amplifier, the seventh all primary power control panels, eighth, power amplifier tube rack, and the ninth contains the tank circuit and antenna tuning remote control devices.

In the photograph Figure 5 is illustrated the back of the nine control panels and in this picture reading from right to left are the three rectifier panels, then the crystal control, modulator, 500-watt amplifier, all primary power control, power amplifier tube rack and at the extreme left the tank circuit and antenna tuning remote control system.

Entirely Automatic

The installation is entirely automatic and is controlled by a push button. Every type of relay is employed in this installation for guarding against either overload or unload, excessive water temperature, and all other conditions arising from a change in electrical constants of the transmitter.

In the photograph shown in Figure 3 may be seen the primary power supply for the 200 k. w. rectifiers. At the left are the contactors to start the rectifiers, then the 3 transformers, each weighing about 3 tons apiece and standing 7 feet high. At the left of the generators may be seen the excitor, then one of the high voltage generators, next the motor in the middle and another generator at the right end. At the top and in the extreme right may be seen the fan used for the water cooling system.

Condenser Microphone

Another one of the devices designed by the E. A. Beane Engineers for the Standard Radio Company may be seen in Figure 1 which is a condenser microphone, the interior of which is illustrated in Figure 2. These are designed to take the place of the ordinary carbon microphone without any changes in the

circuit. The output level of the condenser microphone is the same as that of the carbon. It cannot overload and there is no rustle. These microphones are particularly adapted for picking up

organ selections and in use at WJJD, WLS, KMA, WFBM, WSBT. It is small, light and compact, has very few electrical parts and its frequency loss is practically negligible.

Preliminary Analysis of the Loftin-White Circuit

Article on Page 86 Serves as Basis for Laboratory Study; Some Possibilities Revealed

By R. K. PEW

(Technical Editor)

MESSRS. Loftin and White gave a paper on their Cascaded Direct Coupled Tube Systems as operated from alternating current at the Rochester convention of the Institute of Radio Engineers on November 18 and 19, 1929. Incorporated in this paper were detailed the various steps in the development of this amplifier, the theoretical operation of the various types of amplifiers and a statement as to the operation of same as a broadcast re-

tions their measurements were made. (Their article starts on page 86.—Editor.)

The purpose of this preliminary analysis of this type of amplifier was to determine the constants of the circuit and from these fixed values determine the characteristics under different operating conditions, that is, varying input voltages.

Simplest Adaptation

The most simple of the various circuits were selected. This consisted of a single 224 tube and a 250 output tube. A half wave rectifier with a twenty henry choke and three microfarads of condenser for the filter circuit were used. The filter output was 540 volts at .070 amperes.

The schematic circuit of the amplifier is illustrated in Fig. 1, with all circuit constants as used during the measurements.

In Fig. 2 is the schematic circuit of the amplifier as existed during the measurements. In Fig. 3 is illustrated the amplifier and the associated measuring equipment.

Apparatus Calibrated

The apparatus was set up as illustrated in Fig. 2 and calibrated as follows: the input circuit consisting of a

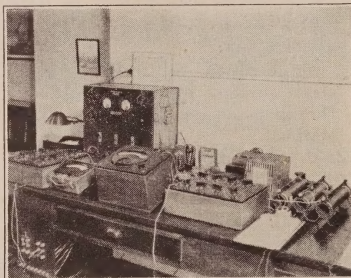


Fig. 3. The amplifier and associated measuring equipment is shown here

ceiver and a few voltage amplification versus frequency curves. They failed to state, however, the majority of circuit constants and under what condi-

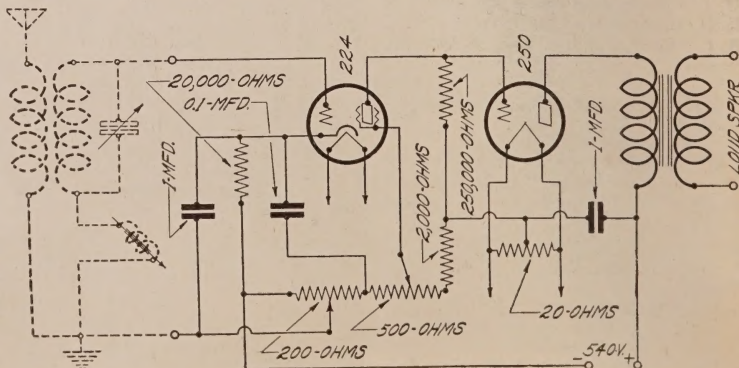


Fig. 1. This is a schematic circuit of the amplifier with all circuit constants as used during the measurements

.002 ampere thermo-couple and a 200 micro-ampere micro-ammeter were calibrated at .001 amperes. The variable shunt resistance of 10,000 ohms was placed across the input circuit of amplifier. $E = R \times I$ giving the input voltage to the amplifier. The output circuit consisted of two series decade boxes and a 4 mfd coupling condenser. The two series decade boxes had a total resistance of 3,200 ohms. The vacuum tube voltmeter had a maximum value of three volts a. c. and was shunted across a known portion of the circuit. The remainder of meters in the circuit were for the purposes as indicated by their position. The alternating current input was generated by a General Radio Type 377 low frequency oscillator.

Measurements were made at 90, 120, 240, 500, 1000, 1400, 2000, 3000, 4000, 6000, 8000 and 10,000 cycles. Input voltages were selected as .5, .1, .5 and 1.0 volts. Curves were made at all frequencies listed at these input voltages and voltage amplification derived by E_o/E_i .

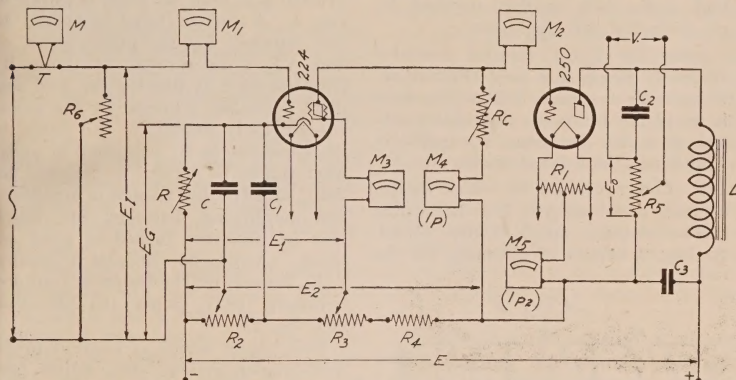


Fig. 2. The above is a schematic of the amplifier during the measurements

With the system at rest the effective grid bias of the 224 tube was two volts negative, as measured by a static voltmeter. 540 volts was the output of the filter circuit at 70 milliamperes. This voltage was divided into 387 volts on the plate of the 250 tube and 157 volts applied to the resistor in the plate circuit of the 224. This would give an applied voltage on the 224 of 102 volts. The screen voltage was selected at 15 volts. The plate resistance of the 224 in these measurements was set at 250,000 ohms.

In Fig. 4 are plotted the voltage amplification curves for the different input voltages as indicated.

Curves Plotted

In Fig. 5 has been plotted the curves for the effective grid bias of the 224 against a change in input voltage. It will be noted that with an increase in input voltage the variation of grid bias between two widely separated frequencies increases materially. As an example, at .1 volts input the bias at

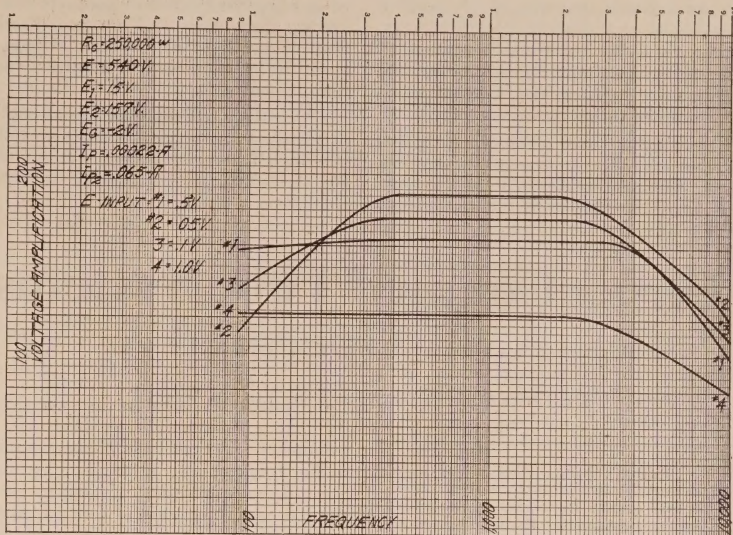


Fig. 4. Voltage amplification curves for the different input voltages

ninety and ten thousand cycles is practically the same, whereas at 1 volt input the bias at ninety cycles is .15 volts higher than at ten thousand cycles. Considering that this amount of change in grid bias will have a considerably greater change in the plate circuit of the 224 and consequently a change in bias of the 250 output tube, the effect should be shown in the voltage amplification at the different voltage input values. A study of the curves in Figs. 4 and 5 will show the resulting action on the voltage amplification with a variation of frequency and input voltage values.

Conclusion

In order to use the foregoing outlined

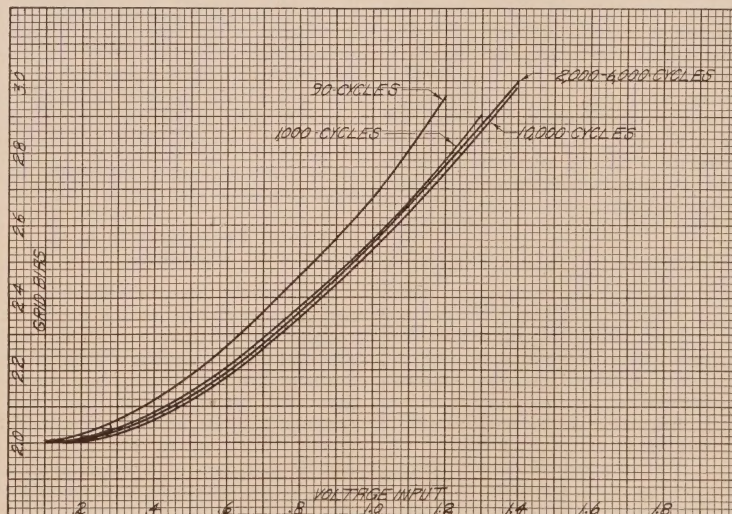


Fig. 5. The curves for the effective grid bias of the 224 against a change in input voltage are plotted here

amplifier with the specified values of resistance and voltages, it will be necessary to know the exact conditions of operation and input values in order to properly regulate the frequency response and overall gain.

The antenna and phonograph connections with the associated transformer and condenser as shown by dotted lines in Fig. 1 are indicated for the purpose

of showing the method of properly connecting these items and not to indicate that the amplifier will operate satisfactorily as a phonograph amplifier or radio receiver.

[We will be glad to hear from engineers who do any measurements on this circuit. If our laboratory can be of any assistance, we will be glad to help. —Editor.]

Direct Coupled Tube Systems A. C. Operated

By EDWARD H. LOFTIN and S. YOUNG WHITE

[Editor's Note. This paper was delivered by Messrs. Loftin and White at the Rochester convention of the Institute of Radio Engineers November 18th and 19th, 1929. It is quite likely that it will appear in one of the forthcoming Proceedings of the I. R. E.—Editor.]

Statement of Problem

IN any audio amplifier or detector-amplifier the following characteristics are desirably essential:

1. Minimum frequency discrimination; 2. minimum wave form distortion; 3. minimum hum if a. c. operated; 4. reasonable high gain from the tubes used; 5. low cost; and 6. permissive large tolerance in manufactured parts.

In a. c. operated direct coupled cascaded tube systems the characteristics depend upon or are influenced by the following features:

1. Maintaining the operation of all tubes at the midpoint of their operating or output current curves, or what may be termed stabilizing against "drift" tending to arise from—(A) changing tubes (they are not all alike), (B) change of constants or conditions due to—(a) aging of resistors, (b) temperature coefficient effects in resistors, (c) line voltage modifications, (d) grid emission from tubes, (e) gas current in output tubes, and (f) manufacturing

tolerances. 2. Feed back phenomena at audio frequencies; 3. the hum problem; 4. motor-boating; 5. trigger action; 6. maximum gain of tube; 7. providing current for auxiliaries, such as speaker field; and 8. increase to very high gain, such as that required by photo-electric cell operation.

Since the direct coupled cascaded system is usable as a most effective detector-audio amplifier it is well to keep in mind the following desirable essentials of which the system is capable in addition to those listed above:

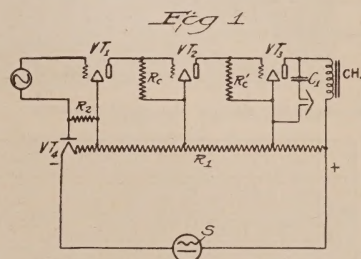
1. Low grid bias for weak carrier currents and high grid bias for strong carrier currents, automatically self-adjusting; 2. supply of potentials for the

Our a. c. work had to be commenced and carried on in large part with commercially non-available a. c. high mu tubes such as we could get constructed on special order, and we secured them in both the heater type and filament type cathodes having mus ranging from 16 to 80. In the case of the filament type for raw a. c. heating it was found practically desirable to go as low as $\frac{1}{4}$ volt on a heavy filament, since the excellent amplifying ability of the system at 120 cycles makes even very slight filament hum troublesome.

It is thought that the technical and practical features that have been encountered in our research and experiences which have led to arrival at an extremely simple, efficient, and remarkably hum-free a. c. operated system will be more certainly understood and appreciated if we follow through some of the developments that have resulted in success in one way and another.

An early workable a. c. operated system employing our specially constructed a. c. high mu tubes is shown in Fig. 1. A current large compared to that required for the plate circuit of tube VT_3 flows through resistance R_1 from source S to develop the grid and plate potentials required by the tubes. In our early experience we found a large current in R_1 necessary to avoid what might be termed a "trigger action," an effect not wanted in amplifiers and amplifying detectors, but which may be otherwise turned to good account. (Article by Nicholas Minorsky, E. E., Journal of The Franklin Institute, February, 1927, pages 181-209, Vol. 203, No. 2.)

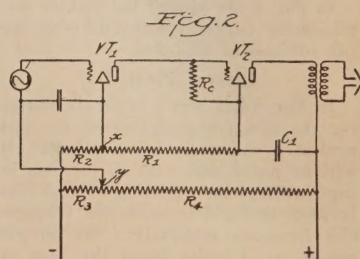
This trigger action is peculiar to direct coupled systems and, unless harnessed, may operate to prevent operating the last tube at the midpoint of its plate current curve, so essential to good amplification. It is apparent that in the arrangement of Fig. 1 if the plate current of the total current through R_1 , there is possibility of changes in this plate current so effectively modifying the bias of preceding tubes as to result in snapping the plate current of VT_3 to one or the other ends of the curve and holding it there in an effective blocked or saturated condition of the last tube, and therefore render the system further in-



radio frequency tubes sufficiently filtered to prevent modulation hum.

Some Procedures in A. C. Operation

Some of the inherent difficulties we had to overcome in making the direct coupled cascaded system stable and practical are discussed in a prior paper ("Direct Coupled Detector and Amplifiers with Automatic Grid Bias," Proceedings Institute of Radio Engineers, March, 1928), by us, but because of lack at that time of commercial a. c. tubes having sufficiently high amplification constants for satisfactory direct coupled operation we confined our discussion to battery operated systems.



Engineering Roster

Our editorial department maintains a roster of engineers engaged in the radio industry.

Inquiries as to location of engineers are welcomed.

We also solicit advice concerning staff changes so this roster may reflect the greatest accuracy.

effective until something is done to re-establish original conditions.

Continuing with Fig. 1, the output of the last tube comprises a choke coil and condenser combination which tends to localize audio signal current flow (except in the case of lowest frequencies), thus limiting audio signal current in arm R_1 where, if present, it can cause regenerative phenomena due to being able to act on the grids and plates of preceding tubes.

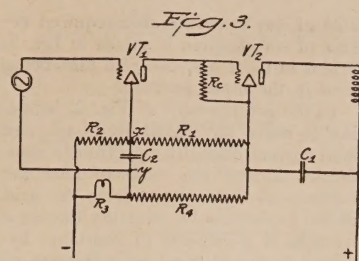
The system of Fig. 1 is prevented from drifting (is stabilized) by the inclusion of the filament of tube VT_4 , the 199 type for example, in the arm R_1 . The emission from this filament flows through the resistance R_2 , and with the filament operated at a critical point for emission, a slight change in current through the filament changes the plate current and therefore the potential across resistance R_2 . This potential across R_2 is the biasing potential for tube VT_1 , and with a proper choice of constants a relatively small change in plate current of VT_3 produces a large change in the grid bias of VT_1 .

Obviously the degree of plate current of tube VT_3 is dependent upon its grid bias, but since its grid bias is obtained from the flow of plate current of tube VT_2 through resistance R'_c , and so on through the system to tube VT_1 , a change in the grid bias of VT_1 will carry through the system; that is, the grid bias of VT_1 is the controlling factor in determining the degree of plate current of VT_3 .

Thus, the tying together of the plate current of VT_3 and the grid bias of VT_1 by a means generating an effect opposing any change in VT_3 's plate current, the system is corrected against drift and the plate current of VT_3 can be set at a desired point and be substantially maintained there.

In using the 199 type of tube as the stabilizer VT_4 , we prefer to operate at a temperature at which the filament is just on the threshold of emission (32 milliamperes), so that the thermal inertia is great and requires an appreciable length of time for noticeable change of temperature. With this selection of conditions any audio frequency component flowing in R_1 is much too fast to noticeably affect the emission, but any effect enduring more than a second or so will give the filament of VT_4 time enough to change temperature and emission sufficiently to correct the result of the effect. Thus the arrangement is in effect a low pass filter for everything beyond the order of several cycles per second, and consequently relieves the grid of VT_1 from any audio signal current effect flowing in the arm R_1 .

The practical undesirability of high current in the arm R_1 and use of a rather costly tube as a stabilizer in the



arrangement of Fig. 1 is overcome in the arrangement of Fig. 2.

In this Fig. 2 arrangement a proper choice of constants permits the elimination of a part of the arm R_1 across the supply filter, and a regular transformer output can be used with the last tube, the audio circuit being completed by a condenser C_1 .

The stabilizing effect is accomplished in a bridge formed by resistances R_1 , R_2 , R_3 , and R_4 . Since the object of drift prevention is to avoid any permanent displacement of the point of operation in the plate current curve of the last tube, the plate current of the last tube is passed through resistances R_1 and R_2 to give opportunity for control thereby. The resistances R_3 and R_4 , forming the other two arms of the bridge, are connected across the relatively unvarying potential of the filter supply, and the resistance values of the bridge are so chosen that with normal plate current in the output tube the potential between the balance points x and y of the bridge is of correct polarity and magnitude for a desired grid bias of VT_1 .

With such an arrangement when anything happens to vary the plate current of the output tube the potential across R_2 likewise varies, while the potential across R_3 remains substantially constant. The result is the development of a counter grid bias potential for VT_1 opposing a change in either direction in the plate current of the output

tube. As a practical matter, the arrangement is designable to be capable of maintaining the system of Fig. 2 against drift within very close approximation to a predetermined desired operating adjustment against a rather wide variety of conditions tending to cause drift.

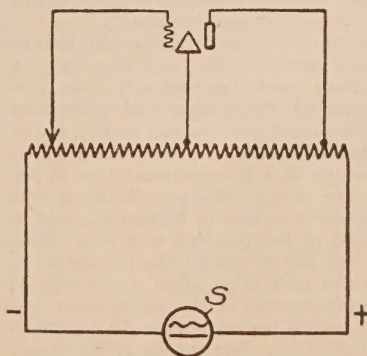
One drawback of the arrangement of Fig. 2 is that hum currents, if the system is a c. operated, and audio signal currents are in assisting phase in the arms R_2 and R_3 with respect to the grid bias of VT_1 , thus making it difficult to handle hum producing features and signal current feed-back features. Since only small resistance is needed in arms R_2 and R_3 , success through by-passing of the hum and signal currents can be had only in the use of several hundred microfarads of by-pass condenser inserted, for example, between the points x and y . Since the difference of potential between these points is very small, it is not outside of the realm of practical possibilities that a decidedly small and cheap electrolytic condenser of sufficient capacity to be effective can be produced, but for the time being no such condenser with satisfactory life characteristics is known to be commercially available.

The hum and feed-back problems of Fig. 2 can be met by substituting for the by-pass condenser idea a thermal effect along with a re-arrangement of the bridge system, these features being included in the arrangement of Fig. 3.

Here the two major legs of the bridge are connected in parallel with respect to the plate current of the output tube, thus making the hum and audio current components in them of like direction and phase. Under these conditions if the arms R_2 and R_3 are substantially balanced for direct current components in establishing the grid bias potential for VT_1 , likewise the hum and audio current components are substantially balanced.

In order to make attempted changes in the predetermined plate current of the output tube effective to produce a correcting change in bias potential of VT_1 , a thermal effect is employed. For example, the resistance R_3 may be the filament of an ordinary 10 watt, 115 volt incandescent lamp caused to operate at a dull red heat by selecting the right amount of current for this operation in choosing the value of resistance R_4 . At such a temperature the filament of the usual incandescent lamp changes its resistance pronouncedly with slight temperature changes either side of the selected point of operation. Since R_2 is an unvarying resistance, any change in the plate current of the output tube divided between the arms R_2 and R_3 will result in an unbalance to develop a correcting change in the bias potential of VT_1 .

Fig. 4.



Due to the high thermal inertia of the filament of the incandescent lamp, the bridge only unbalances for effects lasting an appreciable fraction of a second, thus eliminating audio frequency signal current effects. For this reason no feed-back difficulty is had with the arrangement of Fig. 3. The condenser C_2 shown is merely a radio frequency by-pass condenser which need be included only when the arrangement is intended to function as a carrier current detector.

The hum resulting with a. c. energizing of the arrangement of Fig. 3 may be made indeed low in the presence of extremely poor filtration, and the reason why such result is obtainable may be more readily explained by reference to the simple diagram of Fig. 4.

Here we have an arrangement similar to what is commonly termed the "Miller bridge," it being noted that in the figure we supply the direct current energizing components from the bridge arm. If

able of any encounterable required degree of stabilization is shown in Fig. 5, in this instance a screen grid tube being used in the input position.

In the arrangement of Fig. 2, in trying to solve the signal feed-back and hum current difficulties previously mentioned, attempt was made to filter the currents of these effects from the grid of the input tube by inserting therein a fraction of a megohm of resistance bypassed to the filament by a fraction of a microfarad of condenser. All these attempts were frustrated by motor-boating production at the period of the filter employed. When the screen grid tube became available, it was immediately realized that the screening grid introduces hum and audio signal feed-back, and like attempts to isolate this element by filtering also led to motor-boating.

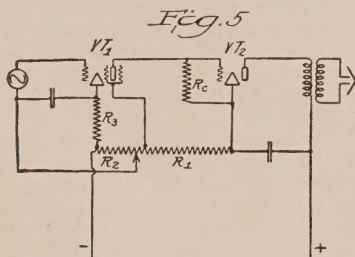
Further investigation disclosed the fact that effective filtration without motor-boating could be obtained by inserting a filter impedance R_3 in a position common to the circuits of all three elements of the screen grid tube, as shown in Fig. 5, the location bringing about a cancellation of the effects tending to motor-boating production.

A resistance R_3 , combining as it does both the plate current and the screen grid current, develops rather a large potential across its terminals when of a value to be effective for low frequency current filtration. In order to obviate this fact being a disadvantage and rendering the system inoperative, advantage was taken of it to form a bridge composed of resistances R_1 , R_2 , R_3 , and the impedance of the tube combined with resistance R_c . For example, R_3 may have 20 volts developed across its terminals when the system is balanced. Then, merely for analysis, we may assume that it is desired to have the grid bias of VT_1 , initially set at zero. In order to overcome the 20 volts of R_3 , the grid return is made to a point on R_2 substantially 20 volts positive, thus cancelling the 20 volt potential across R_3 to leave an initial zero bias for VT_1 , and with everything in balance. It is of course understood that any initial bias can be given to VT_1 by selecting the point of return of the grid circuit to a position on resistance R_2 .

Now with the balance established, or any selected initial grid bias setup, a strong carrier current will cause pronounced rectification and consequent increase of plate current in VT_1 , say of the order of 10 per cent. The potential across R_3 will consequently rise to say some 22 volts, thus contributing 2 volts towards a negative bias on the grid in lieu of the previous zero bias. However, this is not yet the full action as there also takes place a decrease of plate current of the output tube, and since the potential across R_2 is a function of the plate current of the output

tube, the differential potential developed in R_2 will be reduced. That is, where we originally had 20 volts of R_2 opposing 20 volts of R_3 to give zero bias with no incoming signal, we now have 18 volts in R_2 opposing say 22 volts in R_3 to give an effective bias of 4 volts. It is thus seen that the stabilizing arrangement of Fig. 5, including as it does a differential effect, permits of the development of most powerful stabilizing reaction to attempted drifting arising from very strong carrier currents.

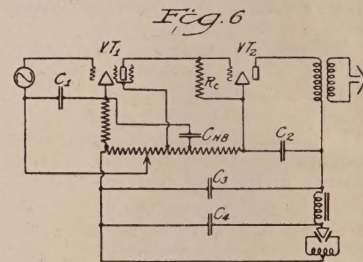
While the problem of stabilizing is more than adequately solved by the stabilizing arrangement of Fig. 5 for all encounterable requirements in practical uses, it isolates the grid of VT_1 from the hum source R_1 , R_2 , and consequently completely eliminates the use of the Miller bridge arrangement for hum neutralization. However, because of the freedom of the direct coupled system from phasing and harmonic effects, it



attempt be made to balance out the hum of the fluctuating source S , it is found that when the grid potentiometer is moved far enough to the left to have the grid fluctuating component neutralize the plate fluctuating component, the tube is in a practically blocked condition. However, in our mode of operating the direct coupled system we resort to such high impedance conditions that we closely approach the blocked condition, and therefore our form of operation is automatically adapted to hum neutralization on the Miller bridge principle, so that the hum in the system of Fig. 3 is in practice remarkably low in spite of an extraordinarily cheap filter.

The system of Fig. 3 has a limitation in that the amount of change of grid bias potential of VT_1 in practical construction is not sufficient to adequately compensate the system against the effects of strong carrier currents when using the system as a detector. The amount of compensation obtainable is however amply sufficient when the system is used as an audio amplifier where only limited cause for drift exists, such as changing from one tube to another and change in potential of energizing supply.

A system having an arrangement cap-



is admirably adapted to hum elimination by hum bucking. The arrangement of Fig. 6 shows one practice, and a very simple one, we employ most effectively for hum bucking in the presence of an extremely poor filter. It comprises merely a connection of the filament to a point of preferably variable selection on the resistance R_1 through a condenser C_{hb} of 1/10 microfarad for example. If it were not for the variability in the commercial screen grid tubes the connection to R_1 might well be once determined and left fixed.

Operational Characteristics

Almost an endless series of different characteristics and performances may be obtained from direct coupled cascaded systems, so that through choice of elements in number and character, circuit constants and potentials, the uses to which such systems may be put are manifold. In carrying out our work we have been repeatedly surprised and gratified with new and seemingly impossible results.

For example, Fig. 7 is a simple 2-tube system comprising a 224 screen grid tube as input and a 250 power amplifier as output, supplied from a single half wave 281 rectifier. The general constants are shown or later stated.

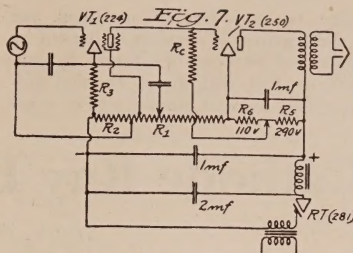
With this simple system we obtain over-all voltage amplifications ranging from 50 to a seemingly impossible 1000 through selection of constants and energizing potentials. By adding a second 224 tube to make a 3-tube system we have increased the over-all amplification to 50,000 even with a 245 power amplifier output, and know no reason why the 3-tube system cannot be worked up to a calculated over-all amplification of 250,000 with careful selection of optimum values in the case of each 224 tube, though this is a matter we have not as yet had time to practically determine.

To give a practical idea of the effectiveness of these systems, the 2-tube one gives good dynamic speaker volume on most of the New York broadcast stations at a point in the heart of the city using only antenna input, while the 3-tube one accomplishes the same result on a 3-inch coil for a number of stations. The 3-tube system, preceded by a band-pass filter, makes an extremely good broadcast receiver. In general, the 2-tube system is about 10 times as sensitive as the power detector, 1-stage audio system.

It is well to here point out that the damping of a tuned input circuit is extremely low in the direct coupled system, and more so when the screen grid type of tube is used because of elimination of the effect on the input circuit of the capacitive reactance of the output circuit. In other words, when using the system as a detector-amplifier real selectivity and resonant rise is had in the input circuit compared to other forms of detection, thus lessening the amount of tuning needed in the preceding radio frequency system. In fact, the selectivity had in the single circuit when coupled directly to an antenna is unusual.

In the case of three electrode tubes the over-all gain depends upon the mu of the tubes and the value of coupling resistance R_c , with the exception that with low values of R_c wide changes of mu do not make much difference. In going to screen grid tubes the over-all gain further depends upon plate, screen grid and grid potentials.

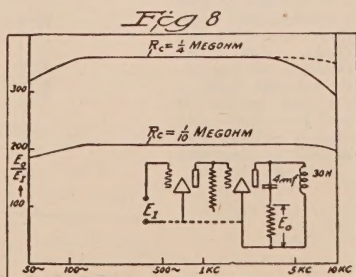
The two graphs of Fig. 8 show with the aid of logarithmic abscissae and linear ordinates the measured and plotted voltage gain throughout the entire audio range of the 2-tube system of Fig. 7, the system being the same for the taking of both graphs except for change in the value of coupling resistor R_c and suitable change of screen grid potential, 1/10 megohm being used in one case and 1/4 megohm in the other, as indicated on the graphs. The skeleton diagram accompanying the graphs shows and states the details of the output of the system employed in measuring for these graphs. In Fig. 7



the potential developed by the filter was 650 volts at 50 milliamperes, 400 volts of this being across the 250 output tube and 250 volts across the arm R_2 . Grid potential with the system at rest was about 2 volts, and screen grid potentials were 45 and 30 volts respectively. A 400 mu 224 tube was used.

In order to operate on this occasion with the high potential of 180 volts on the plate of the 224 tube, the 400 volts across the 250 tube was divided into the 110 volt and 290 volt portions by high resistances R_6 and R_5 respectively as shown, the high resistances avoiding noticeably increasing the current drain on the filter. R_c was connected at this division, thereby adding 110 volts to the 250 volts in R_2 , a total of 360 volts to divide into 180 volts across coupling resistance R_c and the plate of the 224 tube, this equal division being what we term "symmetrical operation." Of course the 180 volts across R_c is too much for grid bias of the 250 tube, but the opposed 110 volts in R_6 nicely reduces the over-all grid bias to a satisfactory 70 volts. It might be added that generally we operate the systems with a potential distribution on plate and across R_c equal to the normal bias potential of the succeeding power amplifier tube, as in Fig. 6, thereby not requiring the R_5 and R_6 resistance of Fig. 7. In this case only 140 volts is required across the resistance arm, thus making the filter output 540 volts for 250 tube operation.

The 1/10 megohm graph shows the most substantial gain of 208 substantially uniform from 140 cycles to 5 kilocycles with a loss of but 10 per cent at the low point of 50 cycles and a loss of but 6 per cent at the extreme range of 10 kilocycles. These end



droops can in large part be accounted for in the frequency-reactance relations of the output circuit, substantiating the theoretical constancy of the direct coupled amplifier per se.

The 1/4 megohm graph shows the much greater gain of 360 (80 per cent increase) substantially uniform from 140 cycles to 3 kilocycles. Like the 1/10 megohm graph, it shows a 10 per cent loss at 50 cycles, indicating that the increase of R_c has no effect on the low frequency side. However, the 10 kilocycle point shows an increase of loss to 16 per cent. This fact requires a little consideration, for it is obvious that if R_c be increased to the megohms region we frequently use the high frequency fall off may become of serious proportions.

The fall off is due to a feed-back effect. In the direct coupled system the increasing of the resistance of R_c makes the feed-back through the internal capacity of the non-screen grid output tube increasingly effective and, being a capacitively reacting plate circuit feed-back at the high frequency end for most output systems, the feed-back decreases amplification increasingly with increase of R_c . Of course, if we succeed in getting a screen grid power amplifier we need give the matter no further attention, there being none of this action in the screen grid input tube, but for the time being properly chosen but simple feed-back neutralizing easily overcomes this effect in large degree. By way of example, the dotted portion of the 1/4 megohm graph shows the improvement had with a hastily adjusted neutralizer arrangement.

While we have cited some explanatory examples around a zero grid bias of the input tube, in practice we generally set an initial bias of about 2 volts to allow for the fact that the emission pressure in some tubes may be such as to start a grid current at 1 volt. In general we have the screen grid potential low, as we usually operate with but a few microamperes in the plate circuit and a too high screen grid potential will materially reduce amplification. It is also necessary to adjust the screen grid potential to operate near the mid point of its current curve, as in the case of all plate electrodes, as otherwise this additional member in the system may cause some severe unwanted rectification on its own account.

From what we have explained in connection with arrangements for drift correction in direct coupled systems it may be seen that these effects, and that of the arrangement in Figs. 5, 6, and 7 in particular, may be used to advantage in the usual detection systems, and further are capable of automatically producing large voltage differences for automatic volume control effects without the addition of an auxiliary tube. If

there should be need for it, we can carry the drift correction responsiveness to such low frequency that the system can be made capable of high amplification for frequencies as low as 1 cycle. Usual audio work allows plenty of room in which to obtain drift compensation without interfering with the very lowest audio tones.

One very interesting characteristic is the ability to receive unmodulated C W signals without heterodyne for printer, tape or other relay operated recording, it being apparent that the high frequency rectifying action that carries through the system is of the square wave type and ideal for the necessary result.

The mildness of the hum difficulties is apparent from examination of the rectifier and filter system constants of Fig. 7. Here we use a single wave (281) rectifier followed by a single stage filter of 2 and 1 microfarads respectively separated by a 20 henry choke. The 2 microfarad condenser is really not used because needed for filtering, but to develop the required high potential from the 281 tube. Another high voltage 1 microfarad condenser is used in the signal circuit of the output tube. Even with this cheap and insignificant filter and half wave rectifier our hum is well within commercial estimate of what is tolerated. When it is appreciated from Fig. 8 that the gain at 60 and 120 cycles is practically the same as elsewhere, the result is really astounding.

Of course we have little or no difficulty with hum from induction, there being no effective magnetic pickup in the system, and wiring loops are easily taken care of. Even in the extremely high gain systems mentioned electrostatic shielding is all that is necessary, and we all appreciate how simple and cheap electrostatic shielding is compared to electromagnet. Close location of parts is not at all a troublesome feature.

Reference to Fig. 7 also makes clear that there is plenty of high potential and current for energizing the tubes of a preceding frequency amplifier without increased drain on the filter, and also, for energizing the field coils of dynamic speakers, the current in the arm R, being adequate for this. The system also lends itself to push-pull operation as two complete systems in push-pull relation, or the equivalent of simple push-pull output tubes, but in view of the extremely fine characteristics we really see no need for push-pull for the reasons it is now so generally employed. Photo-electric cell operation becomes a simple and satisfactory matter through the medium of the very high gain amplifier.

While other features of interest could be touched upon, and many of those

taken up considerably amplified, the present writing is necessarily limited by space and like considerations. In general we feel that direct coupled systems offer unusual possibilities in space

and cost savings, our estimate being that the present radio receivers, amplifiers and like apparatus can be reproduced with improved quality at costs well below those now existing.

Cathode Ray Tube Television

By V. ZWORYKIN

(Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.)

[Editor's Note. — Mr. Zworykin's paper on "Television with Cathode Ray Tube for Receiver" was presented at the Eastern Great Lakes District convention of the I. R. E. at Rochester, New York, November 13-19, 1929. The paper in full is to appear in a forthcoming issue of the Proceedings of the Institute of Radio Engineers.—Editor.]

THE problem of television has interested humanity since early times. One of the first pioneers in this field, P. Nipkow, disclosed a patent application in 1884 (P. Nipkow, English patent No. 30105, January 6, 1884), describing a mechanical scheme for television. It involved a scanning of the object and picture, for which purpose the familiar perforated disk was employed. The scanning disk is used even now, almost without alteration, in all practically developed schemes of television apparatus. However, Nipkow's ingenious invention could not materialize in his day because of the lack of powerful modern aids—the photo-cell and radio amplification. At present the rotating disk is giving excellent results within the mechanical possibilities of our time.

Proposed By Rosing

Out of a number of other methods which have been proposed for the solution of television by various inventors, the author (U. S. Patent application, March 17, 1924) has been attracted by the application of the cathode ray for scanning purposes. This method was proposed for the first time by Boris Rosing, professor of physics in Petrograd, in 1907 (English Patent No. 27270, December 13, 1907). The same reasons which handicapped Nipkow prevented Posing from achieving practical results. Later Belin and Holweck (Belin et Holweck, Bull. No. 243 de la Societe Francaise de Physique, p. 35. S. March, 1927), Douvillier (A. Douvillier, Revue General de L'Electricite p. 5. January 7, 1928) and Takayanagi (K. Takayanagi, Jour. I. E. E., Japan No. 482, pp. 932, Sept., 1928) were working in the same direction with various degrees of success, striving to develop television reception by means of cathode-ray tubes.

Has Advantages

The cathode-ray tube presents a number of distinct advantages over all other receiving devices. There is, for

Fig. 1. The construction of the transmitter is shown in Fig. 1. A light source is provided by an ordinary 6-volt automobile lamp. The light is focussed by a condensing lens L upon a diaphragm D with a small orifice. From there the beam of light emerging through the orifice is reflected upon a vibrating mirror M and focussed into a sharply defined spot on the moving film F. (See Fig. 2.)

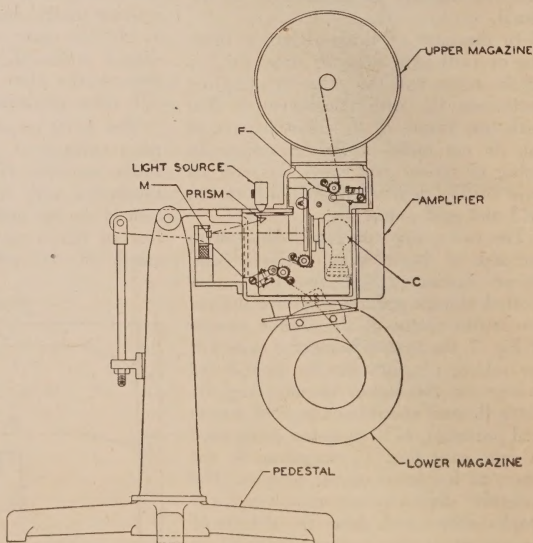


FIG. 1

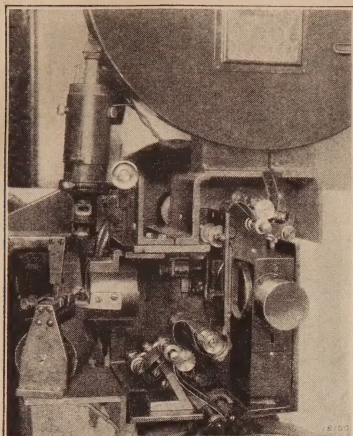


Fig. 3. The vibrating mirror is shown in the above photograph. It consists of a small steel rod with a vane placed between the poles of an electromagnet

example, an absence of moving mechanical parts with consequent noiseless operation, a simplification of synchronization permitting operation even over a single carrier channel, an ample amount of light for plain visibility of the image, and indeed quite a number of other advantages of lesser importance. One very valuable feature of the cathode-ray tube in its application to television is the persistence of fluorescence of the screen, which acts together with persistence of vision to the eye and permits reduction of the number of pictures per second without noticeable flickering. This optical phenomenon allows a greater number of lines and consequently better details of the picture without increasing the width of the frequency band.

This paper will be limited to a description of an apparatus developed in Westinghouse research laboratories for transmission by radio of moving pictures using the cathode-ray tube for reception.

Fig. 2. With the mirror *M* vibrating at a frequency of 480 cycles about a vertical axis the light spot sweeps the film horizontally. This vibration of the mirror combined with the downward movement of the film causes the light spot to explore the whole surface of the pictures

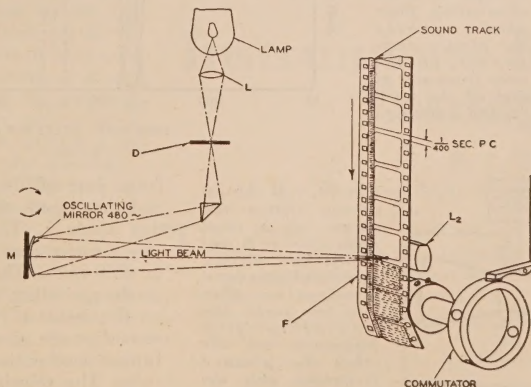


FIG. 2

In the author's opinion, if a receiver is to be developed for practical use in private homes, it should be designed without any mechanically moving parts. The operation of such a receiver should not require great mechanical skill. This does not apply to the transmitter, since there is no commercial difficulty in providing a highly trained operator for handling the transmitter at a broadcasting station.

Transmitter

The transmitter consists of a modified standard moving picture projector. The intermittent motion device, the optical system, and the light source are dismantled. The film is caused to move with a constant speed downward, this

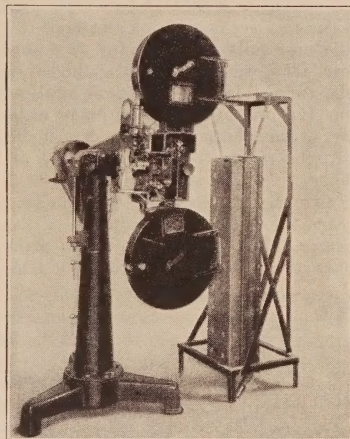


Fig. 4. A general view of the transmitter is shown in the above photograph

motion providing the vertical component of scanning.

Construction

The construction of the transmitter is shown in Fig. 1. A light source is provided by an ordinary 6-volt automobile lamp. The light is focussed by a

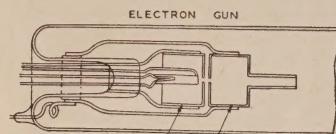
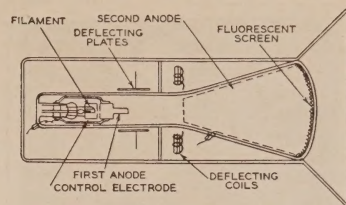


FIG. 5

Fig. 5. This diagram shows the general inside construction and function of the electron gun which is illustrated photographically in Fig. 6

condensing lens *L* upon a diaphragm *D* with a small orifice. From there the beam of light emerging through the orifice is reflected from a vibrating mirror *M* and focussed into a sharply defined spot on the moving film *F*. With the mirror vibrating at a frequency of 480 cycles about a vertical axis, the light spot sweeps the film horizontally. This vibration of the mirror combined with the downward movement of the film causes the light spot to explore the whole surface of the pictures as shown in Fig. 2. After passing the film, the light enters a photoelectric cell *C* which

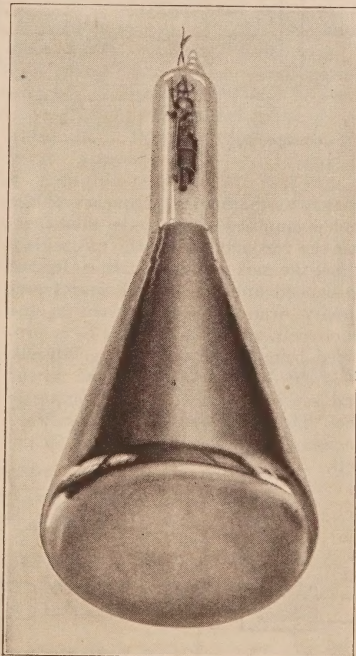


Fig. 6. The type of tube used by Mr. Zworykin in his demonstration is illustrated in this photograph

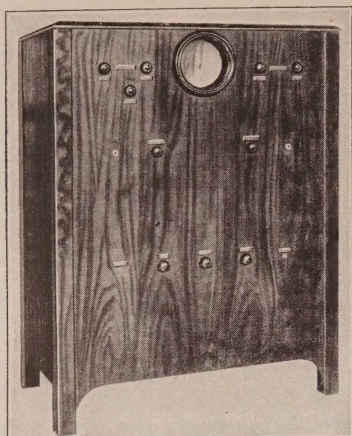


Fig. 7. This photograph shows one type of the receiver used in the test

transforms the variations of optical density in the film into a variable electric current.

The vibrating mirror is shown in Fig. 3. It consists of a small steel rod with a vane placed between the poles of an electromagnet. The poles are U-shaped and each leg is provided with a coil. An oscillating current of the same fre-

From the facts that the horizontal scanning is produced by a sinusoidal current, it follows that the velocity of the beam across the picture is not uniform. The velocity in the center is about 57 per cent higher than that of a spot scanning at uniform rate a picture the same width. Before work was started on the machine, it was anticipated that this feature would be found objectionable and correction by optical filter was planned. Practical tests, however, indicate that the non-uniform distribution of light across the picture is not readily apparent to the eye, and therefore no precautions are now used. A general view of the transmitter is shown in Fig. 4.

Receiver

The receiver consists of a cathode-ray tube especially designed for this purpose. The principles of the cathode-ray tube are well-known from their application to oscillographs. In their ordinary form, however, they cannot be used for picture reception, because although they have scanning arrangement in two dimensions they do not have means for varying the intensity of the picture. Moreover, neither of the main types of oscillograph is suited for tele-

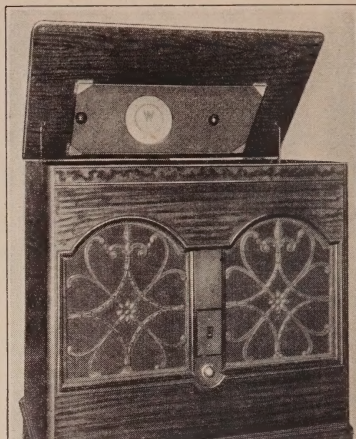


Fig. 8. Another type of receiver more suitable for the home is shown in this photograph

vision purposes. The high potential type, which would give a sufficiently brilliant spot, is always operated in connection with a vacuum pump. Such a pump is impractical for a home television receiver. The low potential type of cathode-ray oscillograph is of the sealed-off type but the amount of light available from the screen is far too small. In order to give sufficient brilliancy for the picture of 5 in. size, the tube should operate at least at 3000 volts. For larger pictures still higher voltage is required, since the brightness increases with the accelerating voltage. According to these requirements, a new type of cathode-ray tube was developed. This is shown in Figs. 5 and 6. An oxide-coated filament is mounted within a controlling electrode C. The cathode beam passes through a small hole in the

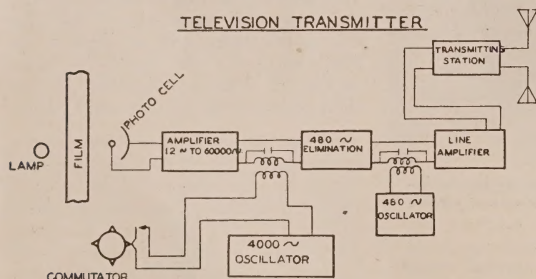


Fig. 9

quency as the natural frequency of the rod is supplied to the coils, thus causing the rod and the mirror to oscillate about the axis of the rod. In order not to depend upon the uniformity of sensitivity over the cathode area of the photo-cell, an additional lens L_2 is provided between the film and photo-cell. This lens is so situated that the mirror and sensitive surface are at conjugate foci. Thus the scanning beam is always focussed upon a stationary spot in the cell.

Fig. 10. The picture frequency together with a framing frequency is passed through a band eliminating filter which removes the picture component of the same frequency as that of the horizontal scanning

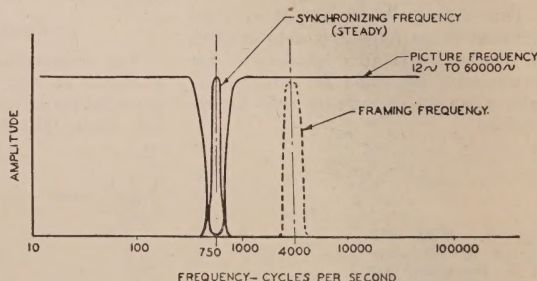


Fig. 10

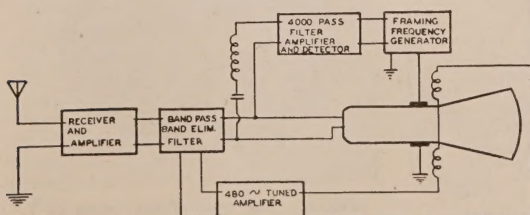


Fig. 11

Fig. 11. At the receiving station the output of a local radio receiver is amplified and divided by a band pass band elimination filter into two parts, one the synchronizing frequency, and the other the picture frequency plus the framing frequency.

front part of the controlling element and then again through a hole in the first anode A. The first anode accelerates the electrons to a velocity of 300 to 400 volts. There is also a second anode consisting of a metallic coating on the inside of the glass bulb. This second anode gives to the electrons a further acceleration up to 3000 or 4000 volts. The velocity of the electrons at this voltage is about one-tenth that of

light. An important function of this second anode is also to focus electrostatically the beam into a sharp spot on the screen. The target wall of the bulb is about 7 in. in diameter and is covered with a fluorescent material such as willemite prepared by a special process so as to make it slightly conductive. Conductivity is required to remove the electrical charges from the screen supplied by the electron beam. This tube will be referred to hereafter in this paper as the kinescope.

Moving the Beam

The beam of electrons can easily be moved across the screen either by an electrostatic or an electromagnetic field, leaving a bright fluorescent line as it passes. For this purpose a set of deflecting plates and a set of deflecting coils are mounted on the neck of the kinescope, outside the tube. The plates and coils are adjusted in the same plane, so as to give vertical and horizontal deflection at right angles to each other. As a result of the location of the deflecting elements between first and second anode, the deflecting field is acting on comparatively slowly moving electrons. Hence the field strength required is much less than that which would ordinarily be used to deflect the beam under the full acceleration of the second anode voltage.

The brightness of the line can be controlled to any desired extent by a negative bias on the controlling element. The bias controls the mean intensity of the picture whose lights and shadows are super-imposed upon this mean intensity. It is evident that if we apply to this controlling electrode the amplified impulses from the transmitter and at the same time deflect the beam in synchronism with the motion of the light beam across the picture on the film, the picture will be reproduced on the fluorescent screen. Figs. 7 and 8 show a general view of two types of receivers.

Synchronization

If separate channels are available for each of the synchronizing signals, the problem of synchronization of the receiver with the transmitter is very simple. For horizontal scanning, it is necessary only to transmit the scanning frequency operating the mirror as a sinusoidal voltage and to impress it on the deflecting coils of the kinescope. The cathode beam will follow exactly the movement of the light beam across the film.

For the framing or picture frequency, a voltage is generated at the receiving end and merely controlled by signals from the transmitter. A condenser is charged at constant current through a current limiting device, such as a two-electrode tube, so that the voltage at the

condenser rises linearly. The deflecting plates of the kinescope are connected in parallel to this condenser, and therefore, when the condenser is charging, this cathode beam is deflected gradually from the bottom to the top of the fluorescent screen at a constant speed. This speed is regulated by the temperature of the filament of the charging tube to duplicate the downward movement of the film. An impulse is sent from the transmitter between pictures, which discharges the condenser, quickly returning the beam to the bottom position, ready to start upward and reproduce the next picture.

For transmission of the complete picture, three sets of signals are therefore required: picture signals, horizontal scanning frequency, and impulses for framing. It was found that it is possible to combine all of these sets of signals into one channel. In this case the photo-cell voltage of the transmitter is first amplified to a level sufficiently high for transmission. There is then superimposed upon this a series of high audio-frequency impulses lasting a few cycles only and occurring when the light beam passes the interval between the pictures. (Fig. 9.)

Transmitted Signal

The picture frequencies together with the framing frequencies are then passed through a band eliminating filter, which removes the picture component of the same frequency as that of horizontal scanning. Following this, a portion of the voltage which drives the transmitter vibrator is impressed upon the signals, passed through the filter, and the entire spectrum is used to modulate the radio-frequency carrier. (Fig. 10.)

At the receiving station the output of the local radio receiver is amplified and divided by a band-pass band-elimination filter into two parts; one the synchronizing frequency, and the second the picture frequency plus the framing frequency. The synchronizing frequency is amplified by a tuned amplifier which supplies current to the de-

flecting coils of the kinescope. (Fig. 11.)

The picture and framing frequencies are applied directly to the control electrode of the kinescope.

The same voltage which modulates the light is impressed upon a band-pass filter, which is tuned to the frequency of the a. c. voltage used for the framing impulses. The output of this filter is amplified, rectified, and used to unbias a discharging triode which is normally biased to zero plate current, and which takes its plate voltage from the condenser which provides the vertical scanning voltage.

Thus, the picture signals and both synchronizing and framing frequencies are transmitted on one channel, and fully automatic synchronization is obtained.

The amplification problem in this case does not differ from that of the amplifier for mechanical television of the same picture frequency. The frequency band for which the amplifier should be constructed is much lower for the same number of lines due to the smaller number of pictures per second.

Conclusion

Those who are accustomed to the conventional scanning disk type of television notice a number of differences in the appearance of the picture as viewed on the end of the cathode-ray tube. The picture is green, rather than red (as when a neon glow tube is used). It is visible to a large number of people at once, for an enlargement by means of lenses is unnecessary. There are no moving parts, consequently no noise. The framing of the picture is automatic; and it is brilliant enough to be seen in a moderately lighted room.

Technically, the kinescope type of receiver presents added advantages. The high-frequency motor for synchronization, together with its power amplifier, is not required. The power required to operate the grid of a kinescope is no more than that for an ordinary vacuum tube.

Instruments for Production Testing Work

By P. MACGAHN

Meter Engineering Department, Westinghouse Electric and Mfg. Co.

THE manufacture of electrical apparatus and in fact manufacturing processes in general carried out on a production basis often involved the necessity for accurate measurements of the electrical quantities.

An example of this is the manufacture of radio vacuum tubes of different

kinds.

The accuracy required for such measurements is in general much higher than that obtainable with ordinary panel or switchboard type instruments. For example it is well known that a slight error in the setting of the grid voltage in the testing of radio tubes

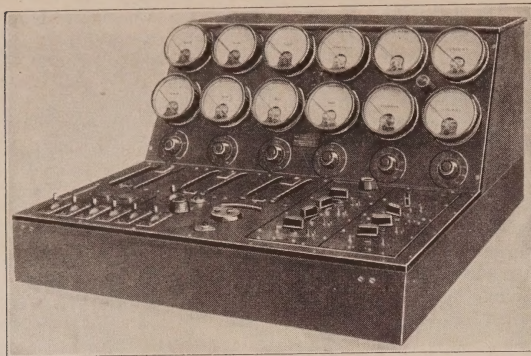


Fig. 1. Radio tube test bench showing instruments mounted on vertical panel at the rear of the bench

will result in a very large difference in the plate current. Therefore if sufficiently close test limits are set on plate currents to assure in this respect a satisfactory tube characteristic many good tubes will be rejected in testing and many defective tubes will be accepted due to lack of sufficient instrument accuracy. Similarly a higher order of accuracy is needed for many of the other production measurements in many manufacturing processes aside from radio tubes.

Switchboard instruments are not primarily intended for close measurement work. Their principal field of application is for operating or control. The pointers are furnished with large index ends to facilitate reading at a distance and for the same reasons the division lines are made very heavy. The calibration accuracy of switchboard instruments is generally of the order of 1 to 3 per cent allowable error. Many of the smaller types of switchboard instruments are furnished with etched printed dials resulting in variable accuracy at different scale points.

The accuracy considered essential and acceptable for switchboard instruments can be obtained without exceptional care in balancing the movement. The design of the bearings, pointers, and other parts are intended to withstand the overloads and rough usage of op-

erating or control work rather than carrying the delicacy required for high accuracy work.

Designed for Accuracy

Portable instruments, however, are designed for use where greater accuracy is required. The preferable position for the use of portable instruments is horizontal and this involves practical difficulties in their application to permanent testing benches designed for speedy production testing such as in radio tubes or similar modern manufacture. It is generally the practice to mount the test sockets on the top surface of the test bench together with the switches and other controls and mount the test instruments on vertical panels at the rear of the bench in a position easily read by the operator making a self-contained outfit. This enables quick readings to be taken.

Figure 1 shows a bench of this character. Typical circuit connections are shown in Fig. 2 as intended for testing $1\frac{1}{2}$ volt amplifier tubes.

With large production it is desirable to specialize the test positions or benches for testing of each piece of apparatus only, therefore simplifying the connections and controls and avoiding multi-range scales on the instruments. This means that in any manufacturing plant there will be many different test outfits as there are different varieties of apparatus to be tested.

Unfortunately in the past there has been as indicated above, a conflict between such test requirements and the use of switchboard type instruments which do not have sufficient accuracy for test purposes.

In order to provide a line of instruments especially intended for this class of service instrument engineers have carefully studied the problems of testing measurements in production for large quantity production work as regards measuring instruments and this has resulted in the design of the so-called "panel standard instruments." These were originally intended for mass production work on vacuum tubes but are of course equally applicable to all

kinds of manufacture where quick high accuracy inspection readings or tests are necessary.

Briefly the "panel standard instruments" consist of the combination of a panel or switchboard type case and mounting into which are placed high-accuracy portable instrument mechanisms. The dial markings are hand calibrated of the fine line type enabling close readings to be taken and the calibration is performed with the same painstaking care and by the same experts that perform the calibration on the high grade portable instruments.

Therefore these instruments possess so far as possible the accuracy and qualifications of the corresponding portable types. The reservation "as far as possible" in the above statement is introduced because due to the horizontal position of the pivot in the bearings of panel mounted instruments there must of necessity be somewhat more pivot friction than in the bearings of portable instruments which are normally vertical in position. This is due to the fact that with a vertical shaft arrangement the contact between the pivot and the jewel is at the center line of the pivot, and therefore the friction works at a much shorter radius than in the case of the horizontal shaft. In horizontal shafts the end play requirement is such that the contact point between the pivot and the jewel is at the side of the pivot and therefore at a point where the effective radius is greater. Consequently, there is more friction effect.

Figures 3 and 4 clearly show the scales and pointers in two of these panel standard instruments. The scales are almost 4 in. long and very clearly divided. The cases however are only $4\frac{3}{8}$ in. in diameter and therefore the instruments are very compact indeed taking up the least possible space on the panel. The cases are made of heavy, soft-drawn steel, which shields the movement from external magnetic fields. A large amount of experience particularly in actual production of radio tubes has shown that this size of instrument is the

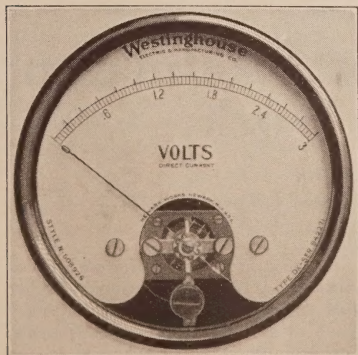


Fig. 3. New Westinghouse panel standard d-c. voltmeter

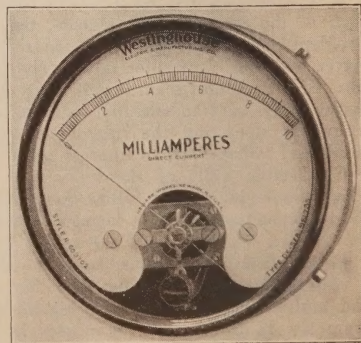
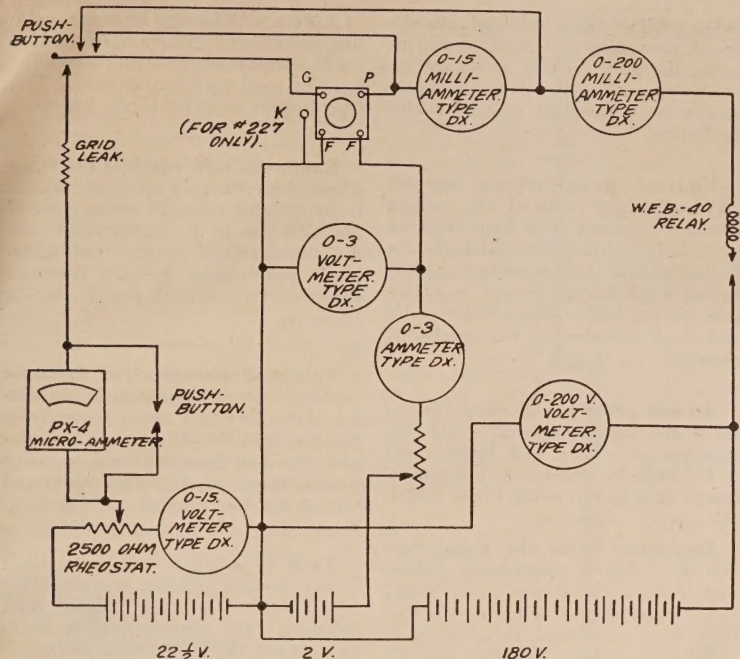


Fig. 4. New Westinghouse panel standard milliammeter, three quarters view



best suited for general production testing purposes.

The scales are long enough to make accurate readings on the lower parts which is often necessary and yet the pointers are not too long which would cause instability or variations in balancing due to moisture or other causes.

The happy combination of portable instrument movements and scales with switchboard cases and mountings is thought to be entirely novel and should find a large application in all kinds of testing work where the otherwise preferable horizontal position of portable instruments cannot be employed.

The general designation of "panel standard instruments" has been chosen as being both descriptive of this new type distinguishing it from "portable standard instruments" and also from the usual switchboard or panel instruments.

MANY requests have come into this department for information on specifications of the various dynamic speakers. In the notes following are given as many specifications as could be secured from the various manufacturers represented. The material given herewith may therefore answer a number of the questions from our readers.

Best

Best Mfg. Company, 1200 Grove St., Irvington, N. J., advises it is their practice to furnish their standard models equipped with an impedance coupling

transformer of either 500 or 4000 ohms output and requests that the transformer be specified. We are also advised that the impedance of the moving coil is .07 ohms and the power delivered to the field coil is at the rate of 27 watts.

Magnavox

Information from the Magnavox Company, Oakland, Calif., states the primary impedance of the stock model input transformer used by Magnavox is close to 6000 ohms at 400 cycles. They have but one standard transformer which is applicable to either 171, 245 or 250 tubes, either singly or in push-pull. Specifications of the transformer referred to are: primary 3000 turns No. 34 enamel copper wire, center tapped. Secondary 85 turns No. 22 enamel copper wire. Core $\frac{7}{8}$ by $\frac{7}{8}$ center section 3 per cent silicon steel. All models carry the same movable coil, namely 92 turns of No. 32 enamel copper wire with a d. c. resistance of 5.3 ohms. The output ratio of the transformer referred to is 35 to 1.

On Models 100, 101, 106, 107, the resistance of the field coil is 2000 ohms, on models 104, 105, 108, 109, it is 7500 ohms. On models 200 and 201 the ohmic resistance is 8.5 ohms while on models 400 and 401 the resistance is 5.4 ohms.

Utah

According to information received from the Utah Radio Products Co., Michigan Ave. at 18th St., Chicago, Ill.,

the speakers which they supply to the jobbing trade are equipped with transformers having an impedance of approximately 5500 ohms at 60 cycles. The push-pull transformer which they supply on order is made especially for two 245 tubes in push-pull. It operates about equally well on 210 or 250 tubes.

Jensen

From the Jensen Radio Mfg. Co., 5601 S. Laramie Ave., Chicago, Ill., we learn the primary impedance of their standard input transformer is 6000 ohms. This transformer has a primary of 2640 turns of No. 36, secondary coil 120 turns of No. 22. The d. c. resistance of the voice coil is $10\frac{1}{2}$ ohms. The a. c. impedance of the voice coil is 15 ohms at 1000 cycles. The voice coil is wound with 100 turns of No. 32 aluminum wire.

Miles

Data received from the Miles Mfg. Corp., 31 W. 21st St., New York, manufacturers of dynamic units and theatrical horns, states that on the M-100 d. c. model the primary impedance is 3800-4000 ohms. The secondary impedance is 12 ohms at 60 cycles. Secondary d. c. resistance is 7 ohms for the voice coil. Field current is 1.2 amps. at 7 volts and 1.4 amps. at 8 volts.

Transformer Corp.

No stock models are made by the Transformer Corp. of America, 2301 S. Keeler Ave., Chicago, Ill. This company advises us that all of their products are made directly to manufacturers specifications.

Wright-DeCoster

Specifications on the model 107 Wright-DeCoster reproducer made by the Wright-DeCoster, Inc., manufacturers, at St. Paul, Minn., are as follows: field wire size No. 24, field current .17 amps., field resistance 340 ohms, voltage field and choke 75, voltage field 55, ampere current 2900, flux density 125, music and voice cone impedance 9 ohms, voice only cone impedance 12 ohms, input transformer primary impedance 4000 ohms, input transformer turns ratio 17-1, bucking coil impedance 1.5 ohms, filter choke 5 Hys., filter condenser 2 mfd.

Operadio

Information covering the dynamics made by the Operadio Mfg. Co., St. Charles, Ill., is given here: Model 106 works direct to the voice coil which has an effective impedance of 5 to 7 ohms. Model 1106 works out of a 171-A, 245 or 250 tube in push-pull and can be used as the output transformer if desired. Model 2106 operates on a high impedance output type 171-A, 245 or 250 tubes singly or in push-pull. Model

3106 works out of a type 210 tube in push-pull arrangement, and can be used as the output transformer of such tube. Model 13106 works out of a high impedance output from a type 210 tube either singly or in push-pull. Model 5106 works out of an amplifier or radio set which has a low impedance output designed to work in to a standard 15 ohm dynamic speaker voice coil. The speakers referred to in the preceding paragraph all have 2500 ohm fields and are of d. c. type.

For operation 110 volt 50 to 60 cycle a. c. model 306 works direct to the voice coil which has an effective impedance of 5 to 7 ohms. Model 2306 operates on a high impedance output from 171-A, 245 or 250 tubes used singly or in push-pull.

Valley

Practically all of the business of Valley Appliances, Inc., electrical equipment, Rochester, N. Y., is done with manufacturers of sets. Therefore, they adapt the Valley speaker according to the output characteristics of the receiver for which the speaker is specified.

Farrand

From the Farrand Mfg. Co., Inc., Long Island City, N. Y., we learn the impedance of their push-pull transformer in the dynamic speakers is 8000 ohms, single tube input in transformers 4000 ohms. The bobbin inductance of their Green Inductor dynamic speaker is 7550 ohms, while the Red is 17,500 ohms at 1000 cycles.

Interesting Developments

[Engineers and others desiring full information on the items presented in this column may secure it by writing to Radio Engineering Section, care of this magazine.—Editor.]

Colonial Radio hangs its dynamic face downward under the chassis, economizing on console or cabinet space.

Pacent announces a combination switch and volume control for pick-up operation, enabling the user to turn instantly from radio to record without disturbing any connections. When the arrow points to position marked "radio" the phonograph is disconnected and ready to play. The first movement, clockwise, connects the phonograph and volume is increased as the knob is further turned.

Sabinite, named after Dr. Paul Sabine of the Riverbank Laboratories, may be used to plaster the walls of a

radio studio. This material absorbs sound, preventing reverberation and insuring the program will go on the air exactly as performed. Its use also permits a more beautiful type of studio decoration.

Unusual precautions against over-emphasized notes of the cabinet resonant frequency have been observed by Fada in their console model where a slotted receiver shelf, open back, vented floors, solid braced cabinet construction, celotex baffle, large speaker grille and shock mounting of the speaker is observed.

An old principle in snap fasteners is now being employed in the construction of a new and better radio socket made by a mid-western manufacturer. It is known as the Cinch socket.

Departing from the usual custom of having a permanently lighted dial on the radio set, the Edison model is using the scheme of having the dial light flash only when the receiver is tuned to a station. The user logs his set in the beginning and then as each position is reached the light will flash. In between the logged positions the dial will not be illuminated.

The bother of having to set the tone arm at a prescribed position for automatically stopping the turntable motor when the end of a record has been reached, has been eliminated in the Oro-tone pick-up supporting arm equipped with a new automatic non-set stop for all standard phonograph records. The stop referred to is so designed as to be built into the base of the arm and in line with the needle to cut off the motor when the needle reaches the central area of the record. By incorporating the stop in the arm it eliminates the former type of stop and switch from the top of the motor-board, increasing neatness of appearance of assembly. The construction of the stop is such that when the needle moves on the central circle it cuts off the current from the motor and stops the revolving of the turntable. When the arm is lifted back to the starting position and clear of the record, the current is automatically switched on and the machine is again in full operation.

Radio, phonograph, dynamic speaker and console, all in one and at a low price is observed as one of the Sentinel offerings this season. This probably indicates a trend on the part of manufacturers to take advantage of the public desire for a combination radio phonograph arrangement at a moderate price.

A firm of Chicago broadcast station consulting engineers has been having exceptional success with the employment of condenser microphones. This type is quite superior to the carbon.

Radio has now reached the stage where it may be coin operated satisfactorily, judging from the recent entry of the Mills Novelty Co. in the radio field. A coin operated receiver and radio-phonograph combination is being manufactured for commercial use in hotels, clubs, etc.

Fabric diaphragms for dynamic speakers seem to be gaining in popularity. According to a recent report from Stevens, 650,000 of these Burtex diaphragms have been delivered so far to manufacturers of the Victor radio and talking machine products.

Utah is using a full wave high voltage contact rectifier instead of the tube rectifier in their model 66-A dynamic. The contact rectifier is directly across the 110 volt a. c. and eliminates the stepdown transformer usually employed.

Janette is now marketing a 32 volt rotary converter enabling the radio dealer to take advantage of farm sections where 32 volt d. c. lighting plants are operated. A filter is provided for cutting out d. c. hum and the unit is equipped with starter and voltage regulator. This should open up additional sales on farms where modern a. c. sets can now be employed with such a converter.

Shakeproof washers have made quite a headway in the radio industry if we are to consider statements made by service men working on factory sets. In the early days quite frequent cause of trouble was a connection working loose under a screw head. With the present type of washers this cause of dissatisfaction has been removed. It is interesting to note that the washers themselves are furnished in two styles, one with internal teeth and the other with external teeth. In addition the soldering terminal is also equipped with teeth.

Stevens announces a new port-able electric phonograph driven by motor with step-down transformer and rectifier, operating directly from the a. c. line. A feature is a small battery compartment. When the portable is used where no a. c. is available, a small switch disconnects the a. c. rectifier and substitutes the battery.

Radio Fundamentals Applied to Wires in Carrier Current Work

(Continued from page 49)

created a demand for more telephone circuits between Washington and Pittsburgh. It was decided to meet this demand by a trial installation of carrier telephone system between Pittsburgh and Baltimore, from which point cable circuits to Washington were available. In view of the urgency of the situation, the apparatus used in the earlier field experiments was adapted to equip the Pittsburgh terminal, while new apparatus was built for the Baltimore terminal. This carrier system went into service and has since been operating satisfactorily.

Principles of Operation

General. An adequate understanding of carrier systems requires a consideration in some detail of the fundamental principles underlying their operation. Some of these principles, which are also important in connection with radio telephony, have already been discussed in previous articles. Emphasis will therefore be placed on those features which pertain more strictly to carrier operation.

The underlying principles of carrier will be described in their application to carrier telephony. Their application to the somewhat different conditions of carrier telegraphy will be treated separately in a later section.

We will first discuss the features which are involved in a single one-way carrier telephone transmission channel, including generation of carrier current, modulation and demodulation or detection. Next will be considered multiplex operation in a single direction, involving separation of channels by selective circuits, followed by a consideration of two-way operation of single and multiplex channels. Next will be presented an explanation of another type of system in which no modulated carrier current is transmitted over the line and of a special mode of carrier current generation particularly adapted to this system. Finally the repeaters used for amplifying the currents of carrier frequency at intermediate points, and certain other matters such as ringing and the assignment of carrier frequencies will be discussed.

Fig. 8 shows schematically the circuits involved in a single one-way channel. The source of carrier frequency shown in a vacuum-tube "oscillator."

Modulation. The process by which the carrier current produced by the oscillator is so combined with the voice currents from the telephone transmitter, that the variations of the latter are impressed upon the former, is known as "modulation," and the tube circuit in which this is accomplished is known as the "modulator."

It will be noted in the circuit shown that the potentials of carrier and voice frequencies are applied in series in the grid circuit of the modulating tube together with a steady voltage from a battery. Owing to the non-linear relation, which exists between the plate current and grid voltage, the output current of the tube is not simply a reproduction of the alternating voltages applied to the grid. In fact, the modulating properties of the tubes result from the interactions between applied voltages which this non-linear relation introduces. The subject of modulation and the action of a modulating vacuum tube has already been thoroughly covered in previous articles and will not be dealt with further at this time.

It has been determined that speech of satisfactory commercial quality in telephony may be secured if the circuit is capable of transmitting all sustained alternating currents whose frequencies lie, let us say, between 200 and 2,000 cycles per second. These limits having been determined, the apparatus may then be designed on the basis of its meeting these requirements as to the transmission of sustained single frequencies.

SERVICE TESTING INSTRUMENTS



FOR the past several months the engineers of the General Radio Company have been developing three new instruments for the radio serviceman's laboratory. As soon as the final inspection tests have been completed, descriptive literature will be sent to all those who have requested it.

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The information accumulated at voice frequencies can be applied directly to the solution of the carrier current problem and incidentally to radio telephony, provided we know what component frequencies are present in the modulated carrier wave and what relations exist between these components and the component frequencies of the modulating or voice wave.

Demodulation. By the term "demodulation" is meant the process of reproducing the original low-frequency modulating wave from the carrier wave upon which it has been impressed. Various methods of accomplishing this result have been known for many years, such as the use of the electrolytic detector of Pupin or of a crystal detectors of various form. All of these operate by virtue of their non-linear current-voltage characteristics. The instrument which has, however, come to be employed almost exclusively for this purpose is the three-element vacuum tube, and the following discussion presupposes its use.

For a concrete example of the use of the vacuum tube as a demodulator, reference may be made to Fig. 8, above, where at the receiving station a modulated wave is shown applied to the input circuit of a vacuum tube. This figure also shows a low-frequency amplifier in the output circuit of the demodulating tube. Because of the bearing of demodulation on the transmission requirements of the system as a whole, we will discuss this matter at some length.

The operation of the demodulating tube is exactly similar to that of the modulating tube, in that if voltages of two different frequencies are applied to its input circuit, there appears in its output circuit, a complex current wave. When the output current wave is resolved into its components, we find currents identical with the two frequencies which had been applied to the input, one component whose frequency is the sum of the applied frequencies, one component whose frequency is the difference frequencies. The amplitudes of the two currents whose frequencies are the sum and difference of the applied frequencies are proportional to the product of the amplitudes of the applied voltages. When, therefore, the received modulated wave is applied to the demodulating tube, we may determine the frequencies and relative amplitudes of the components of voice frequency in the output circuit of the demodulator by considering the interaction of the various pair of frequencies in the modulated wave.

Obviously frequencies in the voice range can occur in the demodulator output circuit only as the difference of two components of the modulated wave. If we subtract the carrier frequency from any component of the upper side band, the result is the original speech frequency which produced that component. The interaction of the carrier and the entire upper side band therefore reproduces all the components of the voice wave with their relative amplitudes, since the amplitudes of the side band components are proportional to those of the original voice components, and that of the carrier is the same for all of them. The reproduction of the original voice wave also results from the interaction of the carrier with the lower side band.

It is evident that since speech can be reproduced from either side band alone, there is no necessity for transmitting both. Accordingly, the selective circuits to be described later can be so designed as to transmit only one side band. At this effectively halves the range of frequencies assigned to each channel, its great importance is at once obvious.

It is necessary to consider the interactions between the frequency components of the side band itself, for if, in the case of telephony, the voice wave includes components of more than one frequency, each will be represented by a corresponding component in the side band. The interaction of two of these component frequencies, simultaneously present in the side band, gives rise to a component in the output circuit of the demodulator, the frequency of which is the difference between those of the corresponding two components of the orig-

inal voice wave. Such currents will have a serious effect on the quality of the reproduced speech, if their amplitude is comparable with that of the reproduced voice currents. The amplitude of this distorting component is proportional to the product of the amplitudes of the two side band components, whereas the amplitude of each of the two components of the desired voice current is proportional to the product of the amplitudes of its corresponding side band component and the carrier. The reproduced voice current can be made large compared with the distorting current only by insuring that the carrier is large compared with the component of the side band. As a result of this, it follows that in order to secure good quality it is necessary that the greater portion of the energy applied to the demodulator consist of unmodulated carrier frequency.

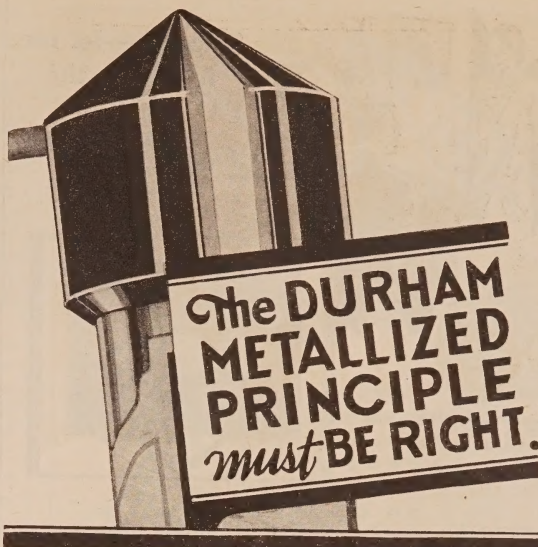
The behavior of the receiving apparatus—that is, the demodulating tube—to interfering currents, such as may be produced by induction from external sources of electrical energy, so-called static interference, etc., can be directly deduced from the above consideration. With properly designed selective circuits only those line currents whose frequencies lie in the range of the side band being transmitted can reach the demodulator. These can produce noise of voice frequency either by interaction with the currents normally associated with that channel or by interaction with each other. Unless the interfering currents are of greater amplitude than the carrier current, in which case commercial operation is impossible, the noise components of the greatest amplitude result from the interaction of the interfering currents with the carrier current. The noise current in the output circuit therefore bears the same ratio to the reproduced voice current as the interfering line current does to the side band current. It follows, therefore, that in designing a system it is the side band current, in which are preserved the characteristics of the speech, which must at all points along the line be kept large compared with the extraneous disturbing currents lying within its range of frequency. This consideration has a very important bearing on the electrical design of apparatus operating on the carrier principle, whether dealing with wire or radio transmission.

While our discussion of modulation and demodulation has been made as concise as possible, it is evident from the foregoing that these two are complementary processes. Modulation may be thought of as elevating the band of essential speech frequencies to a position adjacent to the carrier frequency, and demodulation may be regarded as the process of restoring this band to its normal position in the frequency scale.

Selection—Electrical Filters

When a number of one-way channels, of the type schematically shown in Fig. 8, each employing a different carrier frequency, are operated by superposition on a common line, each channel must be connected with the line through selective circuits which transmit only the range of frequency assigned to that particular channel. Not only must the demodulator assigned to a given channel be prevented from receiving the line currents of other channels, but the sending modulator must be prevented from putting onto the line currents of frequencies outside of its assigned band. The general position of the selective circuits in such a one-way multiplex system is indicated in Fig. 9.

As will be brought out later in the discussion of the behavior of lines with respect to their transmission efficiency at carrier frequencies and with respect to cross-talk between adjacent circuits on a pole line, the most desirable frequency range is rather limited. For this reason, where it is proposed to secure a maximum number of channels simultaneously operating on a given circuit it is necessary to make the frequency interval between the adjacent carrier channels as small as pos-



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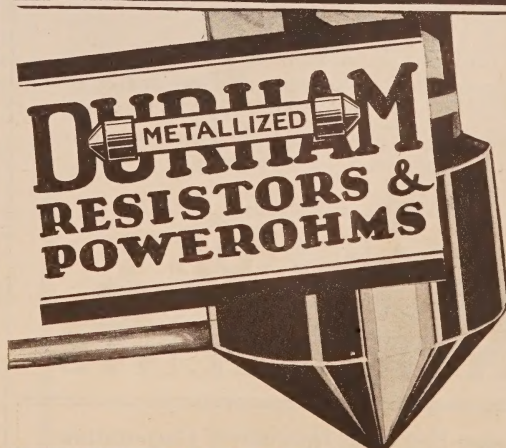
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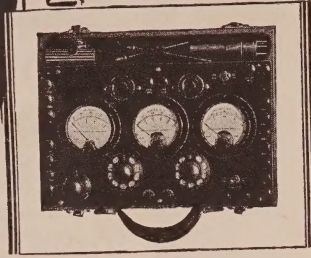
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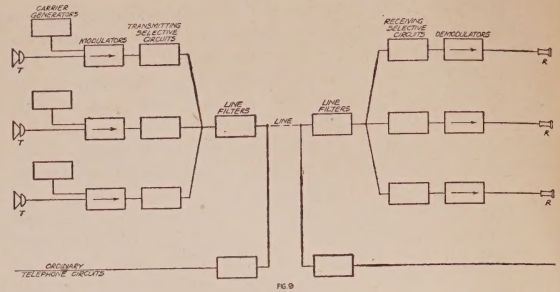
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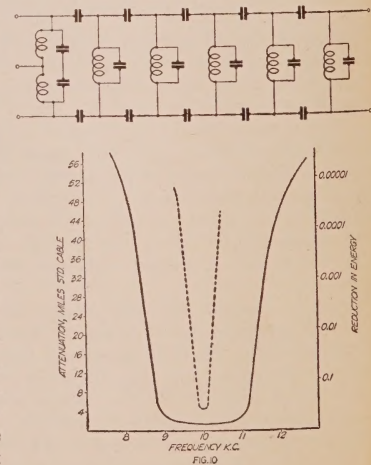


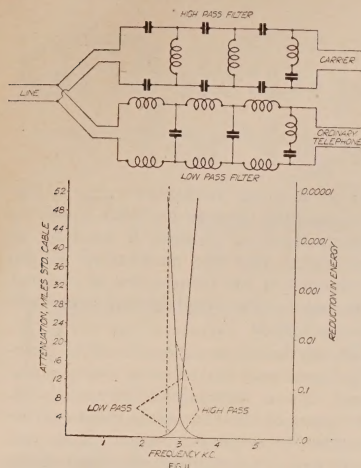
sible. The first limitation to the frequency separation between carrier frequencies is determined by the fact that, as has already been pointed out, the width of the side band must correspond to the voice frequency range; that is, even with ideal apparatus the carrier frequencies must have at least a separation of approximately 2,000 cycles per second. The ideal selective circuit which would permit this close spacing of frequencies is one which would transmit efficiently this side band, having a frequency range of 2,000 cycles and would absolutely block off frequencies outside of this band. Because it is not physically possible to secure such ideal circuits, we are obliged to make a greater separation in carrier frequencies than that made necessary by the width of the side band.

The nearest approach to this ideal selective circuit particularly for carrier operation at moderate frequencies, is secured by the use of what has come to be known as an "electrical filter." This arrangement was invented and thoroughly studied by Dr. G. A. Campbell even before practical carrier operation was made possible by the perfecting of vacuum tubes and the development of their use as oscillators, modulators and demodulators. Campbell's electrical filter is a network composed of inductances and capacities which transmits with a minimum of attenuation currents whose frequencies lie in a predetermined range and attenuates very greatly currents whose frequencies lie outside that range. While these filters may take a variety of forms to meet special needs, they are all alike in that the currents traverse a succession of meshes or "sections," the attenuation effects of which are cumulative. The discrimination against the frequencies which it is desired to exclude may be increased to any physical practical value by increasing the number of sections.

Fig. 10 shows a type of filter which has been used to great advantage in carrier telephony. As this filter transmits a band of frequencies, it has, for convenience, been termed a "band-pass" filter.

The transmission characteristics of this filter are also shown in Fig. 10, where the attenuation introduced into a circuit by the insertion of this filter is plotted against the frequency of the applied current. The attenuation is expressed in miles of standard cable. For the convenience also of those not familiar with its usage there is shown at the right





a scale from which may be read for any frequency the fractional reduction of the energy due to transmission through the filter. This particular filter is designed to transmit the upper side band of a carrier of 9,000 cycles or the lower side band of a carrier of 11,000 cycles.

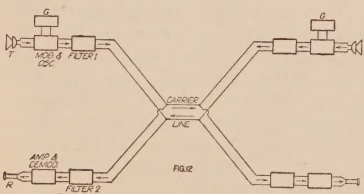
At this point it may be instructive to compare the performance of the filter just described with that of a pair of loosely coupled

circuits resonant to a frequency in the transmission band of the filter. The attenuation characteristics of such a tuned circuit are shown by the dotted curve in Fig. 10. It is obvious from the attenuations of this circuit in the frequency range of the side band that such a circuit is very poorly adapted to the purposes of carrier telephony.

Referring again to the band-pass filter above described, it is of interest to consider the relation between its attenuation characteristic and the operation of the system. The form of the attenuation curve within its transmission range is important from the standpoint of the quality of the transmission of the carrier channel in which the filter is used. If the attenuation is uniform throughout the frequency range which the filter is designed to pass, the effect is merely the same as that of increasing the length of line by corresponding amount, and the loss can be compensated for by amplification inserted somewhere in the system. If the attenuation is not the same for all frequencies within the band, as, for example, if it is greater at the edges than at the center of the band, then the difference in transmission equivalent for different components of the side band will introduce a similar distortion into the over-all transmission frequency curve for various voice frequencies, as measured from the modulator input to the demodulator output. Such a distortion would manifest itself by more or less impairment in the quality of the telephone transmission.

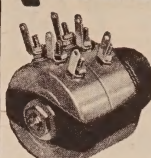
Both the magnitude of the attenuation within the frequency band transmitter and the variation with frequency are dependent upon the dissipation of energy in the coils and condensers, as well as upon the choice of their electrical constants, so that the problem of securing filters of desired transmission characteristics has been largely one of obtaining reactance elements of high time-constants and of high accuracy and stability. For the capacities mica condensers are largely used. For the inductances, special core material of finely divided iron has been developed which has made possible toroidal iron-core coils which are superior in time-constant to air-core coils for frequencies up to the highest value used. At the same time they are more compact and have less stray field. Transformers having similar iron cores are also used throughout the carrier system.

As has been indicated above, the attenuation of the filter outside of its efficient transmission band, deter-

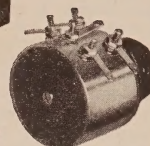


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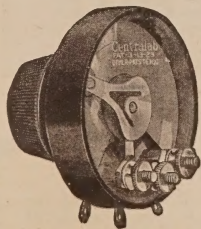
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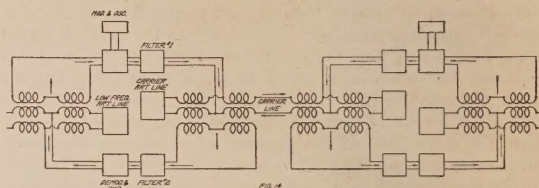
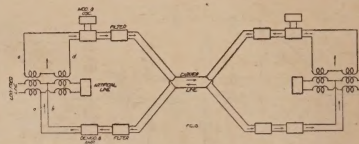
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mines the necessary frequency separation between the side bands of adjacent channels and therefore to a large degree also the number of channels

which may be operated in a given frequency range. For example, if channel *A* is operating through the filter shown in Fig. 10, then the frequency band of channel *B* must be so chosen in the frequency range that the attenuation of the filter in channel *A* for currents of the frequencies of channel *B* is at least as great as some value fixed by the cross-talk requirements imposed on the system.

The attenuation outside of the transmission band is practically independent of the resistance of the coils and the dissipation in the condensers, but is determined almost wholly by the arrangement and values of the reactances employed in a section and by the number of sections. Numerous special arrangements have been devised for controlling the form of the attenuation curve and for giving to the filter an impedance best suited to the circuit with which it is connected. It has been found practicable to design filters which permit of operating with an interval of about 1000 cycles between adjacent telephone channels; that is, 3000 cycles between adjacent carrier frequencies.

In addition to separating the various carrier channels from each other it is found convenient from an operating standpoint to separate within the toll offices the carrier frequencies as a group from the frequencies used for ordinary telephony and telegraphy. For this purpose the portion of the line which is used in common is connected with the carrier apparatus through a "high-pass" filter, which transmits all frequencies above a predetermined value (in this case above about 3000 cycles) and suppresses all frequencies below this value (in this case below 3000 cycles). Similarly connection is made with the ordinary telephone and telegraph circuits through a "low-pass" filter, which in this instance passes frequencies below 3000 cycles and suppresses those above. This combina-



tion of carrier line filters, sometimes called a "high-frequency composite set," is shown in Fig. 11, together with the attenuation curves of the two filters. Referring to this figure, it will be seen that currents in the multiplex line divide between the low-pass and high-pass filters shown at the top of the figure. The division is determined at any particular frequency by the relative input impedances of these two branches. Accordingly, the high-pass filter is designed to offer a high input impedance to currents of ordinary telephone frequency, and to have an impedance equal to that of the line for currents within the carrier frequency range. Correspondingly, the low-pass filter is designed to offer a high input equal to that of the line for currents of ordinary voice frequencies. The attenuation of the high-pass filter is small for carrier frequencies and large for voice frequencies, while the reverse is true for the low-pass filter. Referring to the attenuation curves, which show, as indicated, the attenuation for both the high-pass and the low-pass filters, it is interesting to note how sharp a discrimination is

(Continued on page 110)

Grid Dip Oscillator Now Converted for Operation on A. C. Line

Plate Current Supplied by 226 Tube Used as Rectifier with Grid and Plate Paralleled

DESCRIBED originally on page 94 of the November, 1928, issue of this magazine the laboratory design grid dip oscillator has been built by many technicians and service men. It has always been felt, however, that the design appearing in the November issue was not suited for many who wished to employ alternating current and therefore did not care to be bothered with batteries for the plate and filament supply of the grid dip oscillator.

Revamped for A. C.

Accordingly the design has now been revamped so that the grid dip oscillator is operated from the electric light line. As will be seen in the schematic diagram Fig. 2 a 226 tube with its grid and plate tied together serves as a rectifier, the 110 volt a. c. being applied directly to the plate of the 226. The transformer used for this purpose as well as lighting the filament of the 227 is a Thordarson type 3081 filament transformer. A 30 henry choke type R-196 made by the same concern is used in the positive side of the high voltage rectified output. It is bypassed at input and output by means of the one mfd fixed condensers shown in the drawing. Sufficient filtration is secured by means of this choke and condenser to give practically the equivalent of d. c. on the plate of the 227 oscillator.

Using a 227 as an oscillator the grid circuit consists of one section of the General Radio plug-in coil, the outside extremity of the coil being connected to the grid while the inside extremity is connected to the top of the 5000 ohm modulation resistor. The other section of the coil is connected with its outside turn to the plate of the 227 and the inside turn to one terminal of the 30

henry choke. In the drawing the outside turns are indicated by the letter "O" and the inside turns by the letter "I." The type of coil employed is shown in the photograph Fig. 3 at the extreme right. The regeneration or oscillation control is a fixed one and is represented by the .006 mfd fixed condenser between terminals "I" of the grid coil and "I" of the plate coil. The rotor of the condenser is common for

blown. It is also necessary that extreme caution be used when employing the grid dip oscillator for measurement purposes that no grounded lead of any kind come in contact with portions of the circuit.

A better idea of the connections and the parts employed in the grid dip oscillator can be obtained by referring to the diagram shown in Fig. 4 which is a graphic one. The four terminals

for the plug-in coils are shown at the lower right hand portion of this drawing. The .006 mfd oscillation condenser is located between the two inside terminals, and as shown in the photograph Fig. 1, the Sangamo condenser may rest on the top of the subpanel. As previously explained one of the outside terminals goes to the grid of the 227 and the other to the plate.

Coil Ranges

The range of coil 384A is from 15 to 30 meters when tuned with a .0005 mfd variable condenser. The range of the 384B is from 30 to 80 meters, that of 384C from 70 to 200 meters and 384D, from 190 to 575. Thus the last coil covers the entire broadcast band, while the three preceding types cover the range from 15 to 200 meters, which is ample for any experimental or professional set building work.

While all of the previous ranges given are for ordinary purposes, nevertheless it is possible to obtain sets of coils all the way up to 30,000. For example: 384-E runs from 565 to 1700 meters; the next coil, which is 384-F, runs from 1700 to 4400 meters; after that comes 384-G which tunes from 4400 to 12,000 meters; the last coil in the series is 384-H, which tunes from 12,000 to 30,000 meters.

The schematic circuit shown in Fig.

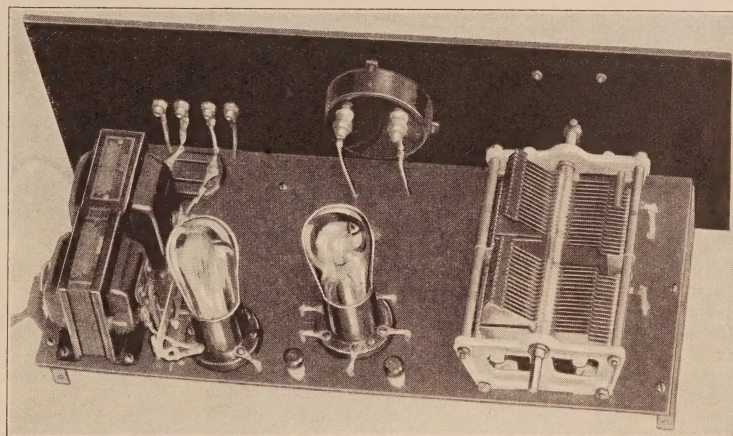
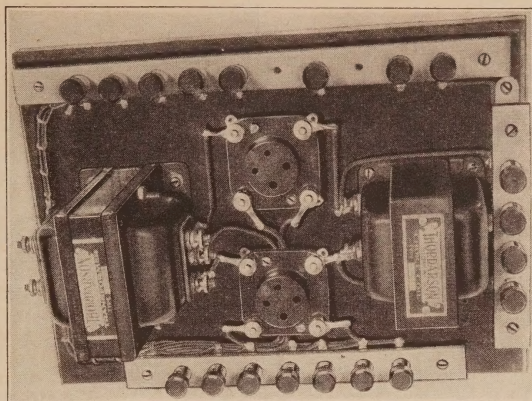


Fig. 1. The completed grid oscillator is shown in the above photograph. The model illustrated in our November, 1928, issue has been revamped so that it is operated from the alternating current line

both sections and connects to the cathode of the 227, and one side of the 110 volt a. c. line.

Do Not Ground Unit

Because one side of the 110 volt a. c. line is common with a portion of the circuit it is obvious that under no condition should any attempt be made to ground this grid dip oscillator. There are several parts of the circuit where trouble would result if the unit were grounded. For example, the positive terminal of the 0.1 milliammeter, the arm of the 30 ohm rheostat, and the rotor of the variable condenser. Of course, if the plug in the 110 volt light socket happened to be in the correct direction nothing would happen. But, on the other hand, if the plug were turned the opposite way the chances are the fuse in the house meter would be



Push pull stage and power supply are first two sections of system which may be extended to serve many purposes

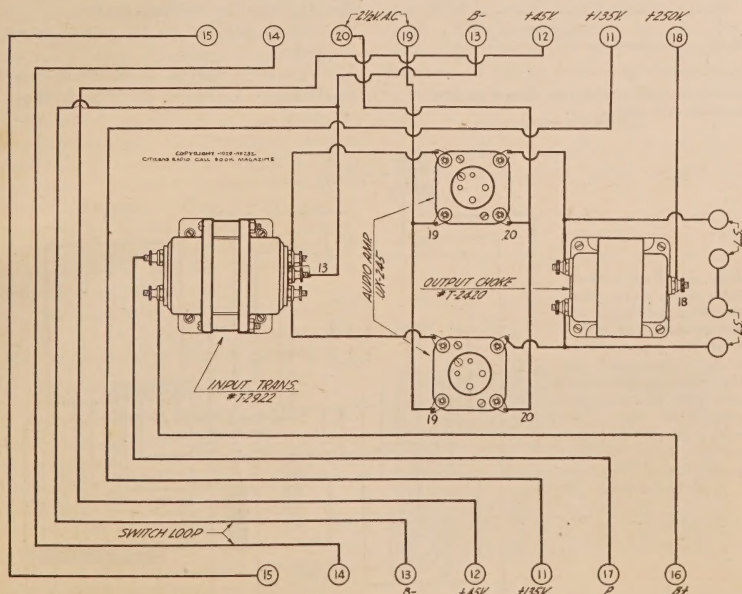
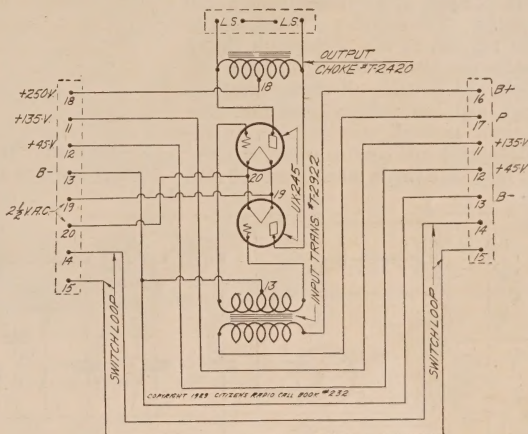


Fig. 2. A graphic diagram of the push pull stage is shown above

head of this page it will be seen that the four binding posts at the right of the picture correspond to the four binding posts at the right of the graphic diagram in Fig. 2. These binding posts are represented in the schematic diagram as the four terminals marked LS at the top of Fig. 1.

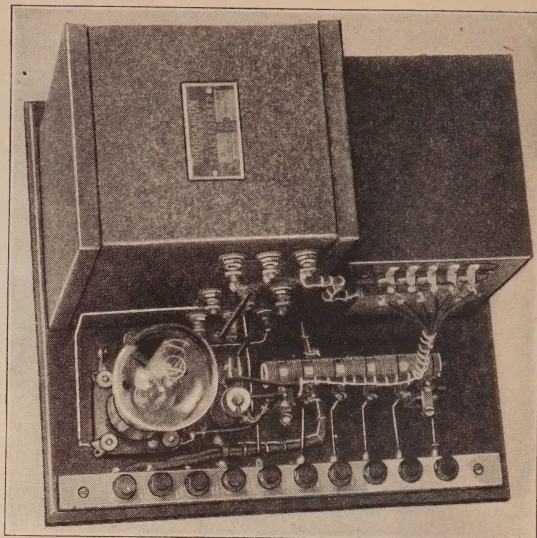
Easily Built

The push pull stage is easily built. It requires a minimum number of parts and connections. The wires leading from one set of binding posts on the input side to another set on the output side may be cabled after the connections have been soldered.

All Needed Voltages

In the power supply a standard R-245 compact is employed with a 280 rectifier. The compact is illustrated at the top left in the photograph Fig. 3 while the filter block is shown at the right and contains all of the necessary high and low voltage capacities. The resistor network may be seen in the photograph and consists of five sections, or taps, on a single tube. The 8500 ohm

Fig. 3. The completed power supply is shown in the photograph at the right. A graphic diagram showing how all parts should be laid out and wired is shown elsewhere on this page



- 2—Benjamin 9040 sockets
19—XL-Bakelite binding posts

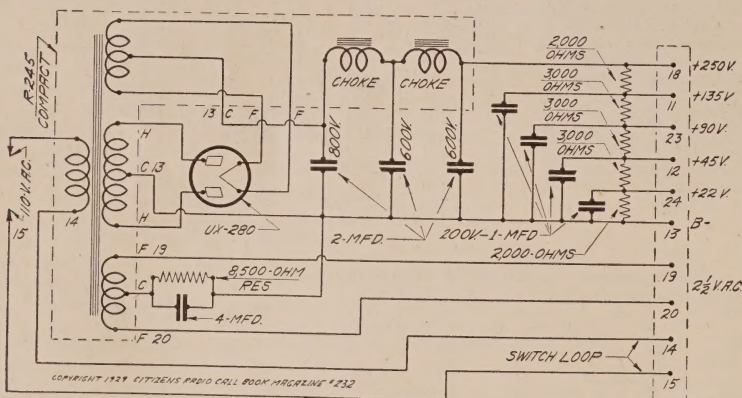


Fig. 4. The electrical constants of the power supply units are shown in the schematic diagram reproduced above

resistor used for biasing the grid of the 245 tube is noted in a vertical position at the right of the rectifier tube in the photograph. Voltages of 250, 135, 90, 45 and 22 are available together with the 2 1/2 volt a. c. for the filament of the 245 tubes.

The layout may be readily built up from the diagram shown in Fig. 5 or if the builder is experienced he may follow the connections shown in schematic illustration, Fig. 4.

Parts Used

Parts from which the laboratory model of the push pull stage and the power supply units were built are shown in the list below:

Push Pull Stage

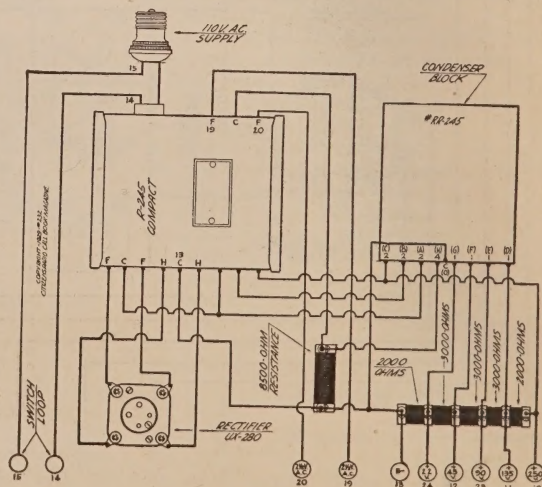
- 1—Thordarson T-2922 input transformer
1—Thordarson T-2420 output choke

- 1—3/4 x 10 x 3/16 in. Bakelite strip
1—3/4 x 4 3/4 x 3/16 in. Bakelite strip
1—3/4 x 7 3/4 x 3/16 in. Bakelite strip
1—10 1/2 x 7 1/2 x 5/8 in. wood base-board
1—Package Corwico Braidite hookup wire

Power Supply

- 1—Thordarson R-245 compact
1—Potter RR-245 condenser block
1—Benjamin 9040 socket
1—85 Electrad 3500 ohm fixed resistance
1—Electrad resistance unit having taps at 2000 ohms, 5000 ohms, 8000 ohms, 11,000 ohms and 13,000 ohms
10—XL-Bakelite binding posts
1—9 1/2 x 10 1/2 x 5/8 in. wood base-board
1—3/4 x 10 1/2 x 3/16 in. Bakelite strip
1—Package Corwico Braidite hookup wire

Fig. 5. For those who have not had much experience in construction of radio units the graphic diagram illustrated at the right is presented. The photograph shown in figure 3 will give the builder an idea as to the appearance of the completed units.



A. C. Self-Modulated Oscillator May Be Help in Servicing Sets

Most Designs Involve Use of Batteries Whereas Service Men Need Unit to Plug in Socket

A LONG with all the former ills of the radio sets the service man is now confronted by new complications in the servicing of modern receivers arising from the single dial control system and by virtue of the fact that the modern receivers are considerably sharper in tuning than the receivers have been heretofore. With this condition predominating in the modern receiver it is almost sure that at some time or other one or more of the various stages of tuned radio frequency will be found out of line with the remainder of the stages.

The slang term for this expression is "out of phase" and when this condition exists the receiver will be broad in tuning and a part of its sensitivity will be lost. This condition arises from a change of tube, aging of radio frequency coils and condensers, and where trimmers of the spring tension type are used the springs will lose their tension and change the capacity slightly. And since it is practically impossible to align a multiple gang receiver by ear and by using a broadcast station as a signal source due to the inherent broadness of a local station and the discrepancy in volume level of the ear it is necessary to have some sort of a signal generating device and an accurate resonance reading device to align the set properly.

Compact Unit

A great many articles have been published and various designs submitted to the service man for units of this type. However, the majority of these designs have incorporated batteries as a power source and also the majority of them having a variable condenser in conjunction with the coil for the purpose of covering the wave band of the receiver. These two conditions existing in such a

design would automatically cause such a test arrangement to be more or less bulky and quite frequently heavy, and when such was carried around by the service man it became quite cumbersome and after a while was usually left behind. With these thoughts in mind the laboratory designed and constructed this tester with the following viewpoints in mind:

Features Desired

Compactness in so far as reasonable.
Elimination of as much weight as possible.

Coverage of the broadcast wave band without the use of a variable condenser which would increase the size of the tester materially.

Shielding sufficient to be able to create a fairly sharp signal on an un-

shielded receiver.

A signal which may be audible in the loud speaker for audible measurements as well as measurable on an output indicating device.

A signal generator that would have an output control to control the signal input to the receiver so that in case a very sensitive receiver is being used the signal may be cut down sufficiently so that it will remain sharp.

An output indicating device that would be universal to all types of re-

ceivers and output circuits, and inasmuch as this type of testing is not dependent upon the fidelity of the receiver this is a comparatively simple matter to take care of.

Standard Parts

All of the parts used in this test arrangement were of a standard nature and may be easily procured from any of the radio jobbers or manufacturers.

Referring to Figure 1, the aluminum can is made by Hammarlund and comes in sections, permitting it to be drilled and assembled in portions and is wired with practically no difficulty at all. It is suggested that all wiring be done with flexible wire so that the jarring and vibration during transportation will not have a tendency to break the connection which would be the condition if solid bus bar were used.

In Figure 1 will be noticed on the front panel within the shield the three X. L. variable condensers. Immediately to the left is the Hammarlund 50 m. m. f. midget condenser which is the output coupling condenser. Immediately below this coupling condenser are the three taps on the selector switch. To the right of this selector switch is the 1000 ohm rheostat which is in the filament circuit of the oscillating tube which controls the filament voltage of

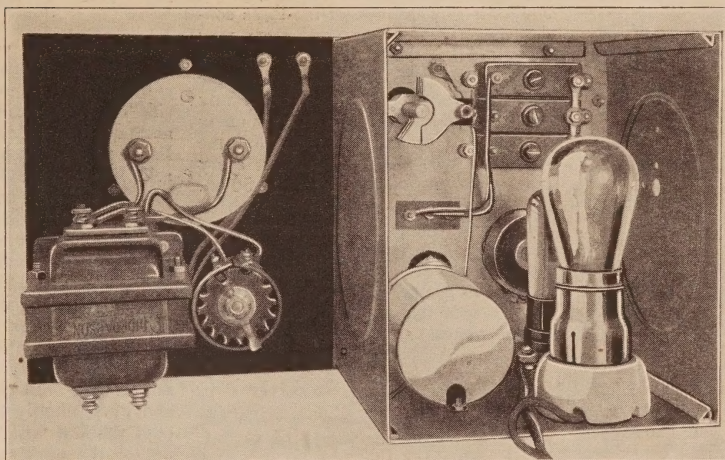


Fig. 1. This illustration shows the back of the tester with the shielding covers removed showing the arrangement and placement of all parts

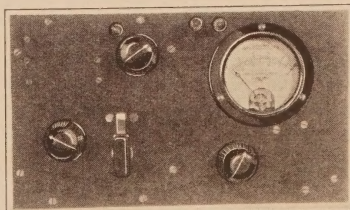


Fig. 2. An illustration of the appearance of the front of the tester

WITH THE ACCESSORY & PARTS MANUFACTURERS



New Resistance Units Designed by Compo Mfg. Co.

REALIZING there is a demand for fixed resistances meeting at least seven specific trade requirements, the Compo Mfg. Co. of Chicago have designed a line of fixed resistance units which they call "Candohms," taken from the fact that the ohms are in cans. An illustration of one of the units is shown in this column.

According to a statement made by J. L. McWeeny, the organization has gone ahead on the general premise that fixed resistors must meet the following specific trade requirements: 1. they must be accurate within 3 per cent of ohm specification; 2. the temperature coefficient must be as low as possible; 3. they must not be easily damaged; 4. they must occupy minimum space; 5. they must lend themselves readily to modern production requirements; 6. they must be capable of heavy overloads for indefinite periods; 7. they must stand up and give perfect service throughout the normal life of the apparatus of which they are a part.



Made in Two Sizes

At the present Candohm resistors are manufactured in two sizes. Type R, the larger size, is delivered in all ohm values from .2 ohms to 12,500 ohms. Type J, the smaller size, ranges from .2 ohms to 6,250 ohms.

One of the interesting features in connection with their winding set-ups is the fact that they wind ohms, not feet. This is believed to be directly opposite to present practice but it does make it a relatively simple matter to comply with a 3 per cent standard of accuracy.

The temperature coefficient of these resistors is considerably less than the normal reaction of the resistance wire suspended in free air. It is widely taken for granted that commercially pure asbestos is an excellent heat insulator.

The technical department of this magazine was supplied with two temperature tables. No. 1 records the test room temperatures, resistance unit metal covered temperature and inner core resistor temperature at all loads from 1 to 15 watts. No. 2 shows test room temperature and wound core tempera-

ture of the same resistor under the same loads but lacking the radiation advantages of the outer asbestos wrapper and protective metal cover. These tables indicate rather conclusively that the winding enclosed in the finished unit operates at a lower temperature than that of the exposed unit. In each case the temperature coefficient is simply that which is characteristic of the wire used. The winding was made of "Advance" wire.

The samples may be hammered and dented without breaking the fine wire winding and without causing turn to turn internal shorts. The cores end in wire terminals and are fabricated from cold rolled dead soft steel tumbled and hot tinned. Because of their unique construction they cannot be pulled out of the assembly. The terminals will withstand more than 25 complete continuous 180 degree bends.

In looking at one of the resistance units that has been cut open, the end view discloses that the resistance winding is on the inside, being wound around a milled edge bakelite base strip. Then follows the terminal wrap, then a dehydrated fibre with an insulation test of 500 volts d. c. and on the outside is a C. R. D. S. steel cover, Duco dipped and furnished in black, white, blue, green, red or orange.

Fit Production Needs

These units lend themselves admirably to modern production requirements. We are advised that the company is in position to supply a wide variety of mounting brackets, furnishing the unit with solder terminals at both ends, solder terminal at one end and a variable length wire pigtail at another end, or wire pigtails on both ends.

The largest permissible wire gauge is used in winding each resistance value. The wire is brought out and given at least four turns around the tinned terminal and then is further clamped with a U-shaped tinned steel collar. The result is extremely low contact resistance between the wire and the terminal inside the unit. Both terminal and collar being hot tinned, the wire is practically imbedded in the softer metal. Where space does not permit the use of large size units and resultant operating temperatures are higher than the oxidizing point of tin plate, Compo supplies parkerized iron covers. This material being already oxidized shows no reaction to high temperature and the internal unit, of course, is capable of standing temperatures of 1200 F.

Another type of resistor which is contemplated is a small Candohm applicable as a grid suppressor or other r. f. uses.

(Continued on page 133)

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(Continued from page 102)

obtained even for frequencies very close to the cut-off points of these filters. For instance, if we select a frequency of 2700 which happens to fall near the upper limit of the normal voice range, it is seen from an inspection of these curves that currents of this frequency are attenuated by about one mile of standard cable when passing through the low-pass filter, but are attenuated by about forty-five miles of standard cable when passing through the high-pass filter. Likewise, a frequency of 3200 near the lower limit of the carrier range is attenuated by less than one mile when passing through the high-pass filter, but is attenuated by about forty-five miles when passing through the low-pass filter. These differences in attenuation correspond roughly to a ratio of energies greater than ten thousand to one.

The location of these line filters in a carrier system is indicated in Fig. 9. A low-pass filter is also used in the output circuit of the demodulator to prevent currents of frequencies higher than the essential voice range from being transmitted to the subscriber.

Two-Way Transmission

Thus far the discussion has been limited to transmission in one direction. Provision must be made, however, for associating these one-way channels with the connecting telephone of power lines so as to permit two-way conversation. In many aspects the problem resembles that encountered in adapting a one-way amplifying element to a two-way talking circuit by means of a telephone repeater. The similarity of the two problems consists not only in the fact that the carrier channel and the repeater element are both unilateral or one-way arrangements, but also that both involve amplification, and therefore the same possibilities of "singing" are present in the case of the carrier as in the case of the repeater. The experience, which was gained in the development and engineering of telephone repeaters, has proved of very great value in connection with the development of carrier current systems.

In Fig. 12 there is shown schematically an elementary form of two-way carrier telephone circuit. Filters are included in the transmitting and receiving branches, as they are necessary in those branches for multiplex operation. This circuit is entirely operative between two fixed telephone stations. If the same frequency is used for transmitting in both directions, there will obviously be an excess of sidetone in the receiver circuits. It is plain that such a type of circuit has very limited commercial application, and it is shown here merely as a starting point for building up the more generally applicable types.

As in general it is desirable to be able to connect any desired power telephone trunk or toll line to the section of line equipped for operation by the carrier current method, it is necessary to adopt for connecting these lines together a circuit of the type which has been studied for many years by telephone engineers, first in connection with subscriber sets, and second in connection with repeater circuits.

Fig. 13 shows schematically one such arrangement. At either terminal of the carrier frequency line, the sending and receiving branches, instead of terminating in a transmitter and receiver, terminate in what are, in effect, conjugate branches of an alternating-current bridge. If the impedance of the artificial line exactly simulates the impedance of the voice frequency line looking outward from the carrier terminal, and an electromotive force applied between the points, a and b, does not cause any current to flow in the branch, d-d, of the carrier current circuit, this represents a condition of zero coupling between the input and output circuits of the carrier system; hence persistent oscillations, i. e., singing cannot be set up. If, however, the balancing network does not accurately

(Continued on page 112)

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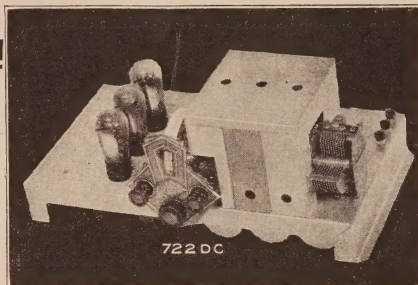
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"S-M 722 a Knockout" —Setbuilders Demand D.C. Design—It's Here!

"722" Results for Battery Users

Experienced setbuilders have learned to expect big results from any screen-grid custom design that S-M offers—but the 722 Band-Selector Seven has broken all records. And no wonder—a custom receiver that is sold, completely wired, at \$74.75 net, topping the performance of widely advertised factory sets selling at twice the price. Yet there is nothing mysterious about it—just the long experience of S-M engineers applied to the job of producing those essential receiver parts whose quality spells the difference between the performance that "gets by" and the performance that an S-M fan demands. Everything that is the "last word" is in the S-M 722—the '24 power detector, the band filter—the uniform gain all over the dial—single dial tuning—all-electric with built-in power supply. Tubes required: 3—'24, 1—'27, 2—'45, 1—'80. Wired, less tubes, \$74.75 net; parts total \$52.90.

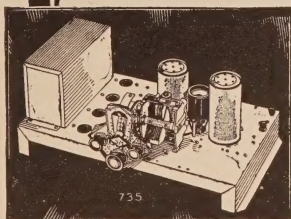
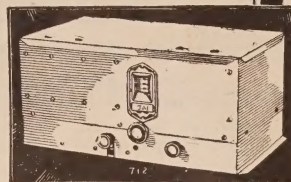
The new 722DC for battery use (illustrated) gives every advantage of the a. c. design—big volume, DX ability, and uniform amplification at all frequencies, just like the a. c. set—truly the ideal battery receiver. Tubes required: 3—'22, 3—'12A. Wired, less tubes, \$57.50. Parts total \$38.50.



Do You Want Absolutely the Best There Is?

It doesn't cost an awful lot more than the 722, but this S-M 712 tuner, in its neat innocent-looking all-metal shielding cabinet, is absolutely guaranteed to out-distance and out-perform all competition regardless of circuit or price—just as its famous predecessor, the Sargent-Raymont 710, did last year. Read, in last month's issue of this magazine, how one listener living only a mile from the powerful WSM tunes in regularly a station 400 miles away with only 20 kc. separation! That's performance—and with one-dial tuning—no verniers. Tubes required: 3—'24, 1—'27. Wired as shown, less tubes, \$64.90 net. Parts total \$40.90.

Any good audio amplifier can be used with the 712; ideal tone quality and perfect convenience are secured by using the S-M 677. Uses 1—'27, 2—'45, 1—'80 tubes. Wired complete, less tubes, \$58.50. Parts total \$43.40. For 25-40-cycle current, \$72.50 wired.



And a "Bearcat" for the Short Waves

"The little 735 is a 'bearcat'. The way it will pick up stations is nobody's business. You want to see the hams come in and play with it. First one I wired I got 5SW Chelmsford, England, also a Dutch station and a lot of others... this was around 2 P. M."

That's the verdict of R. G. Sceli of Hartford, Conn.—one of the most expert setbuilders in New England, and remember he is speaking of the first completely a.c.-operated short-wave sets ever brought out! The new S-M 735 Round-the-world seven is carrying all before it before it. On same chassis as the 722; tubes required: 1—'24, 2—'27, 2—'45, 1—'80; wired \$64.90, parts total \$44.90. 735DC for battery use, using 1—'22, 4—'12A, wired \$44.80. Parts total \$26.50.

Beautiful Cabinets

A full line of cabinets is available for all these S-M receivers—the beautiful 707 table cabinet, in rich crystalline brown and gold, is only \$7.75 net. Other cabinets of remarkable charm are listed in the S-M catalog—see coupon.

"THE RADIOBUILDER" for December contained details of the 722DC; every issue gives advance technical information of great interest and profit to setbuilders. Use the coupon!

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..... No. 9. 675FD Phonograph-Radio Amplifier
..... No. 12. 669 Power Unit
..... No. 14. 722 Band-Selector Seven
..... No. 15. 735 Round-the-World Six
..... No. 16. 712 Tuner (Development from the 14 Sargent-Raymont)
..... No. 17. 677 Power Amplifier for use with 712
..... No. 18. 722DC Band-Selector Six

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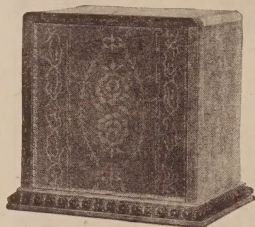
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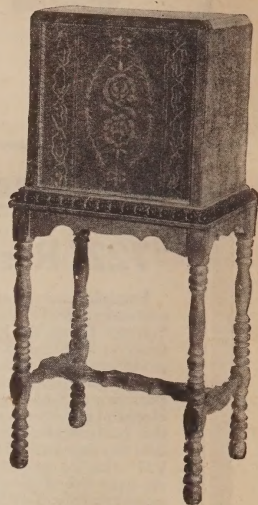
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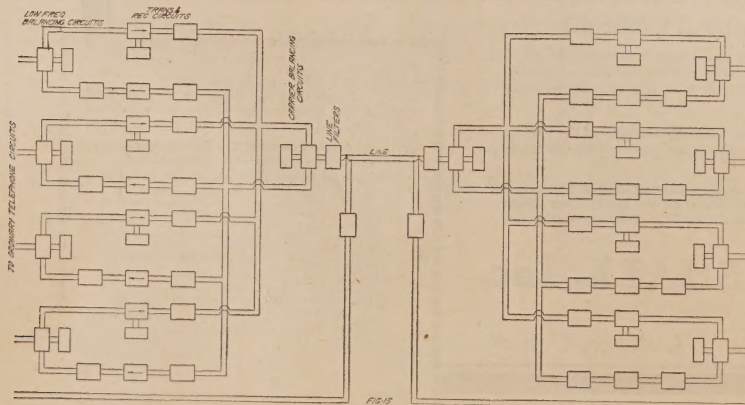
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(Continued from page 110)

simulate the low-frequency line, either of two types of singing may occur. In the circuit arrangement in Fig. 13, if the same frequency is used for transmission in both directions, the type of singing most likely to occur would be local singing at either terminal. This occurs for the reason that in general the amount of energy applied to the two terminals, c and d, is largely amplified in the course of passing through the circuit—modulator, filter 1, filter 2, demodulator and amplifier. If the unbalance in the bridge circuit is such that the fraction of this energy which is fed back to the points, c and d, is as large as that originally supplied, singing occurs. To avoid this type of singing different carrier frequencies may be chosen for transmission in the two directions. If this is done,



local singing cannot be set up, for the reason that filter 2 acts as a block to the return of the output current on itself. End to end singing as distinguished from local singing may, however, occur provided the over-all transmission loss of the line and the terminal apparatus is made less than zero, and provided that there is sufficient unbalance between the artificial lines and the low-frequency lines at both ends. By "transmission loss of less than zero" is meant that the attenuation of the carrier line is more than compensated for by amplification introduced either at the terminal stations or at intermediate repeater stations. However, the accuracy of line balance necessary to prevent end to end singing with carrier circuits such as we have shown is very much less than would be required to prevent local singing if the same frequency were used for transmission in both directions. It is interesting to note that in both of these types of singing the sustained oscillations in different portions of the circuit are of different frequencies. Those in the portions used for transmission at voice frequency have some value lying in the voice frequency range. Those in the portions used for transmission at carrier frequency differ from the carrier frequency associated with that particular channel by the frequency of the oscillations in the low-frequency circuit.

Whereas, with the circuit shown in Fig. 13, local singing is prevented by the use of different carrier frequencies in the two directions, it is possible to prevent this type of singing without resorting to different frequencies, with the attendant

Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

reduction in number of channels, by the use of the arrangement shown in Fig. 14. In this arrangement the energy from the output of the modulator is prevented from reaching the input of its associated demodulator by placing the two in conjugate relation in an alternating-current bridge circuit, of which the carrier frequency line forms one arm, and a balancing network, designed to simulate the line impedance, the other arm.

Both the arrangements shown in Fig. 13 and that shown in Fig. 14 have been successfully employed for two-way carrier current transmission.

We have already discussed quite fully the selective characteristics of filters and their relation to one-way multiplex operation, and have, in the preceding paragraphs of the present section pointed out the fundamental principles of two-way operation. In Fig. 15 is shown schematically an arrangement for two-way multiplex operation capable of giving four two-way carrier conversations in addition to the normal telephone facilities. It will be noted that, in this multiplex system, the basic two-way transmission system of Fig. 14 is employed. A similar two-way multiplex system could be built up employing the basic two-way transmission system shown in Fig. 13.

Carrier Suppression

One of the systems which has been developed, particularly for use in long high-grade circuits, involves certain fundamental principles in addition to those already discussed. It

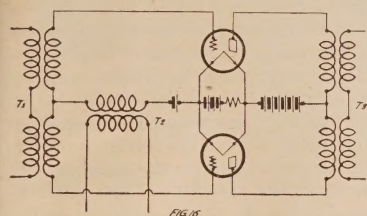


FIG. 15

will be recalled that, as stated, the proper operation of the demodulator requires that the side-band currents, by which are transmitted the characteristics of the speech, be accompanied by a relatively large amount of unmodulated current of carrier frequency. When this carrier current is transmitted from the modulator, it is evident that only a relatively small part of the line current is actually used in conveying the characteristic variations of the voice current. If, therefore, this carrier current is supplied to the demodulator from a local source instead of over the line from the sending station, the amount of line current which it is necessary to transmit per channel is very materially reduced, for then only the relatively small side bands are transmitted. In the application of this method, means must be provided for eliminating the carrier current at the sending end and for supplying it to the demodulator from a local source at the receiving end.

Elimination of the carrier frequency at the sending end can be accomplished by what is known as a "balanced modulator," a schematic circuit of which is shown in Fig. 16. In this arrangement two tubes are connected in a manner somewhat similar to the "push-pull" repeater circuit which is described later. The voice frequency potential is applied through the transformer T_1 . The carrier potential is applied through the transformer T_2 , to the common portion of the input circuit in such a manner that the carrier frequency potentials of the two grids with respect to the filament are at any instant the same. The resultant carrier frequency currents in the plate circuits of the two tubes are then equal, and the fluxes which they set up in the core of the differential transformer T_3 , are equal and opposite; hence no voltage of the frequency of the unmodulated carrier is induced in the output circuit. By a more detailed analysis it can be shown that the side-band currents resulting from the interaction of the carrier and speech-frequency currents are not balanced out but are reproduced in the output circuit. It should be noted that under these conditions, high-frequency current appears in the output circuit

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The chief difference between this year's sets and last year's, between high priced sets and cheap ones, is the difference in audio amplification. This is the difference which the set OWNER HEARS.

R-100 Straight Audio, \$2.25

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BRAIDITE HOOK-UP WIRE

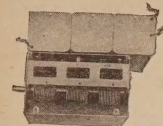
only when low-frequency telephone currents are being applied to the input circuit of the modulator.

Harmonic Generator

In order to insure that the carrier current applied to the demodulator in the above system, employing suppressed carrier, is of exactly the same frequency as that used for modulation at the sending end, an arrangement has been devised whereby both of these frequencies are derived from the same source. For this purpose at one terminal of the system a vacuum-tube oscillator generates a frequency somewhat above the voice range—say 5000 cycles. Current of this frequency is applied to the input of another vacuum tube in such a way as to overload it. This "harmonic generator," as it has been termed, is so arranged that the current in its output circuit has a distorted wave-form containing prominent components whose frequencies are exact multiples of the applied frequency. The various harmonics of the base frequency (in this case 10,000, 15,000, 20,000 cycles, etc.) are separated by suitably designed selective circuits and led into individual circuits where they are amplified and made available for use as carrier currents, each in connection with a different channel. At the same time, current of the base frequency from the controlling oscillator, in this case 5000 cycles, is amplified and transmitted over the line to the other terminal. Here it is separated out by a filter, amplified and applied to a second harmonic generator, which produces the same series of carrier frequencies as does the harmonic generator at the controlling station already referred to. These regenerated harmonics may not only be used for demodulating the transmissions received from the controlling terminal, but may also be used in connection with balanced modulators which send in the reverse direction. The demodulators at the controlling station are supplied with carrier current from the harmonic generator at that terminal.

The suppressed carrier system, besides employing smaller line currents, has two other important advantages. One is the absence of audible beat notes resulting from interaction in the demodulating circuits between the carrier frequency normally present and others which may be present through cross-talk or lack of perfect balance. Where all the carrier frequencies are generated separately, these combination frequencies may in certain cases give rise to disturbing tones within the voice range. With the harmonic arrangement, on the other hand, the only possible frequencies are differences of the base frequency itself and its harmonics, all of which are above the normal voice range, and accordingly are suppressed by the low-pass filter in the output circuit of the demodulator. As a matter of fact, this harmonic arrangement is practically essential where the same frequency is used for both directions.

The second advantage arises from the fact that variations in the attenuation of the line, due to weather changes or other causes, have less effect on the transmission equivalent of the system where the carrier frequency itself is not transmitted. This will be clear when it is recalled that the magnitude of the voice current in the output of the demodulator is proportional to the product of the amplitudes of the carrier and side band currents. If, therefore, the change in line attenuation is such as to increase or decrease the side band current by a given ratio, the carrier current when transmitted will in general also be changed in the same ratio, and the resulting voice current will be changed by the square of this ratio. In the suppressed carrier system on the other hand, while the side band is changed as before, the carrier is increased or decreased—not by the change in attenuation which occurs at the carrier frequency—but by the changes, in general much smaller, which occur at the base frequency, so that the voice current is less affected in this case.

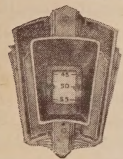
3-STAGE BAND FILTER and R. F. AMPLIFIER UNITS

completely in every detail, except tubes, for immediate installation.

Completely wired, shielded and tested. Band Filter for 10-kilocycle selectivity. Flat-top tuning without side-band cutting. R. F. Amplifier with amazing amplification of 3 Screen-Grid tubes. Both units

SHIELDED POLARIZED R. F. CHOKE

A radio-frequency choke specially developed for modern high-gain shield-grid receivers. Aluminum-shielded and polarized. Minimum external field. No undesired coupling to cause circuit instability or feed-back. High inductance, low distributed capacity. Efficient, compact. Sub-panel connections.

New DRUM DIAL PANEL PLATE

Richly embossed, pebbled bronze, in the modern mode. It has grace and charm appropriate to the superb dial mechanism back-panel that delighted thousands of set builders last season. The control knob can be mounted anywhere on the panel. Illuminated scale.

"HiQ-30"

The World's Premier Custom-Built Radio Because Built with WORLD FAMOUS PARTS

JUST like adding two and two to get four—the result is inevitable when you combine a most efficient circuit with parts the whole radio world respects.

The "HiQ-30" Receiver is Hammarlund-designed and Hammarlund-built. That's all the insurance of quality you need. It is available as a complete kit or you may purchase any of its units separately.

Write Dept. CB1 for circular

For Better Radio
Hammarlund
PRECISION
PRODUCTS

HAMMARLUND MANUFACTURING CO.

424-438 W. 33rd Street, New York

AUDIO TRANSFORMERS Including PUSH-PULL

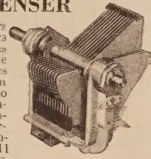
Designed for fidelity of response over the audible frequency range with a sharp cut-off at the high frequency noise level. Large cross-section core of specially treated laminations permits high primary currents without saturation. Completely shielded. Pigtail terminal leads for sub-panel connection.

**SCREEN-GRID TUBE SHIELD**

Essential for '22 and '24 type shield-grid tubes to insure full advantage of their great amplification. Aluminum, with a soft rubber grommet at top to protect control grid outlet. Designed for use with sub-panel sockets. Mounting screws and control grid connector included with each shield.

**The Famous "MIDLINE" CONDENSER**

More than three years the favorite of engineers and advanced radio fans—and still new in the sense that its features and workmanship from the beginning were so far ahead that its popularity has steadily increased and its leadership still stands unchallenged. All standard capacities.

**Chemical Action and Capacity in Storage Battery Described**

(Continued from page 59)

on the negative plate is changed to pure lead and the lead sulphate on the positive plate is changed to lead peroxide and the sulphuric acid will be added to the water. The chemical changes will be as follows:

The lead sulphate and water will produce sulphuric acid, hydrogen and lead peroxide which may be written chemically as $PbSO_4 + 2H_2O = PbO_2 + H_2SO_4 + H$. The changes at the negative plate will be lead sulphate and water produce sulphuric acid, oxygen and lead, which may be expressed $PbSO_4 + H_2O = Pb + H_2SO_4 + O$. The hydrogen H_2 which is produced at the positive plate and the oxygen is O which is produced at the negative plate unite and form water, which will be shown as follows: $2PbSO_4 + 2H_2O = PbO_2 + Pb + 2H_2SO_4$. This last equation starts with lead sulphate and water which are produced when the battery was discharged. It will be noted that we started with lead sulphate and water. Therefore, plates may be charged in water. Badly discharged negatives may even be charged better in water than in an acid electrolyte. In the last equation the sulphate on the plate combined with the water to form sulphuric acid we may then say, with reservation, that during the charge acid is driven out of the plate. When all the lead sulphate has been used by the chemical changes caused by charging current, no further charging will take place. If a current is continued to be sent through the cell after it is fully charged the water will continue to be split up into hydrogen and oxygen, but since there is no lead sulphate left with which the hydrogen and oxygen can combine to form lead peroxide and sulphuric acid, the hydrogen and oxygen rise to the surface of the electrolyte and

is released from the cell. This is known as gassing and is an indication that the cell is fully charged.

[Further data on this subject will appear in a later issue.—Editor.]

New Design is Seen in Pilot P-E-6 S. G. Broadcast Receiver

(Continued from page 55)

who want for themselves or can sell to others a low-priced screen-grid receiver of good characteristics.

The set is known as the P-E-6, and is put out by the Pilot

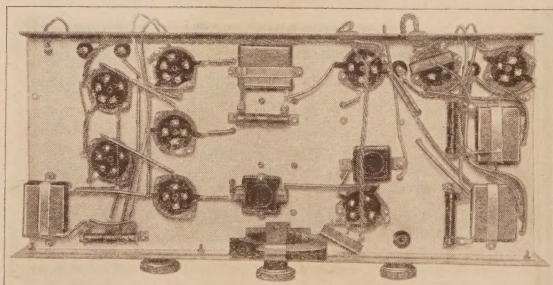
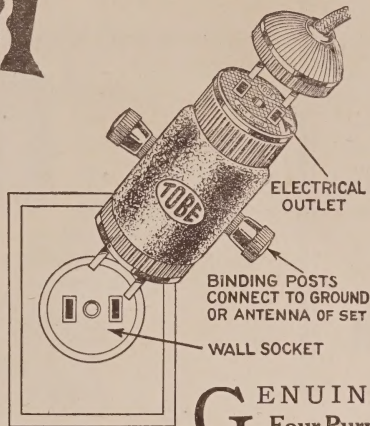


Fig. 3. This shows a bottom view of the chassis and indicates the compact wiring

company in the form of three different kits. The sub-panel and all the electrical components are the same in all cases, but in kit number K-122 a metal front panel, without cabinet



GENUINE Tobé Four Purpose Light Socket Aerial

FREE with one year's subscription to **Citizens Radio Call Book—Radio's Greatest Magazine.**

This device saves the cost and bother of installing an aerial, lightning arrester or ground and at the same time permits the use of an electrical outlet. Just plug in your electric lamp or electric radio set as you now do to baseboard receptacle or lamp socket. Over all dimensions $2\frac{1}{4}'' \times 2\frac{1}{2}''$.

Static minimized—construction of plug prevents excessive pickup of static—increased selectivity—improves tone quality. Tuning is sharpened—your set will tune much more sharply when you use a Tobé Aerial, than when you use an outside aerial. **Each aerial guaranteed for two years, unconditionally.** Full instructions showing many combinations accompany each aerial.

Send This Coupon Today!

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Here is my \$1.75 (Foreign \$2.00) for which please send me a Tobé Four Purpose Light Socket Aerial **FREE** and enter my subscription for the Citizens Radio Call Book Magazine for one year starting with the

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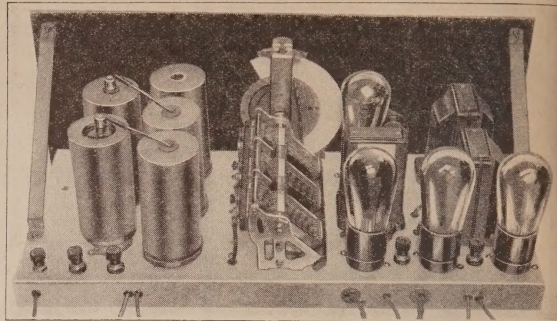


Fig. 4. A rear view of the set is shown photographically with tube shields in place

or power pack, is supplied. This panel is of steel neatly finished to resemble light walnut. A set assembled from this kit may be mounted in any standard 7 by 18 cabinet or console, and may be used with any 171A power pack. Both panels are accurately drilled, and all parts and hardware are supplied.

This second kit, No. K-123, includes a very attractive walnut-finished metal cabinet, the front of which is drilled to form the front panel, to support the tuning dial, a switch and a volume control. The third kit, K-124, is exactly like the second, except that a Pilot K-111 power pack is supplied. The cabinet is 19 inches long, 12 inches deep and 9 inches high. The Pilot power pack fits neatly inside, in back of the sub-panel, and the whole outfit presents a very pleasing and professional appearance.

Push-Pull Audio

Electrically, the P-E-6 comprises two stages of tuned r. f. amplification, with screen-grid tubes, a 227 detector, a 227 first audio stage, and a 171A push-pull stage. The screen-grid tubes and the r. f. coils are enclosed within individual shield cans. Tuning is done by means of a three-gang condenser, mounted in the center of the sub-panel. A formed aluminum sub-panel, completely drilled and all ready for assembling of the parts, is furnished. The purchaser does not have to drill a single hole.

The entire receiver may be wired without the front panel in place. This makes the work very easy, as all the parts are then easily accessible. With the wiring completed, the sub-panel is simply slipped against the back of the front panel, or the inside of the cabinet, and the dial bushing screwed to the condenser shaft. The two wires to the power switch and two more to the volume control (both of which are on the front panel) complete the job. The long flexible wires for the filament and plate "juice" are connected to the power pack, after being enclosed in a short length of large-diameter fabric tubing. This protective sleeve removes the sloppy appearance usual to a group of tangled wires.

The bottom of the cabinet supplied with the K-123 and K-124 kits is removable. When removed, the bottom of the sub-panel, on which all the wiring appears, is readily accessible for inspection, trouble-shooting, etc.

Screen Volume Control

The volume control is a potentiometer which regulates the screen voltage on the two screen-grid tubes. This is a very smooth and effective control, as it gets right at the heart of the set: the amplifying power of the screen-grid tubes.

The primary of the first r. f. transformer has a total of six turns, center-tapped. With an indoor aerial between ten and thirty feet in length, the full six turns are usually used. With an outside aerial, the three-turn section allows 2-degree selectivity if the wire is not more than fifty or sixty feet long. Of

course, local conditions determine the actual aerial construction. In large cities, with a number of powerful stations in the near vicinity, the indoor aerial is recommended. In the country, a progressively larger outside wire is permissible.

The P-E-6 is intended for use with 171A output tubes, although 245's may be used if only the biasing resistor is changed. The 171A tubes are used because they have more than enough power handling capacity for most homes, and because a 171A power pack and 171A tubes are considerably cheaper than a 245 pack and 245 tubes.

The accompanying illustrations give a good idea of the overall appearance and construction of the P-E-6. No detailed assembly instructions are given here because the manufacturer supplies such data with the kits.

Unusual Lighting Effects

A MAGIC illuminating system which changes the shape of a room at will has been found in the most intensely lighted room in the world, atop a New York skyscraper dedicated to the science of sound.

The discovery was made when illuminating engineers, who sometimes move their meetings bodily aboard the Ile de France or other places known to have unusual lighting systems, staged their latest session in the Cathedral Studio of the National Broadcasting Company high up in the tower of 711 Fifth Avenue.

Dr. M. Luckiesh, wizard of Nela Park, Cleveland, personally explained the system he designed, and called into play the entire battery of lights within the studio for the first time. More than 200 lighting engineers were held spellbound by the shifting color effects from concealed batteries which seemed to make the walls of the room advance and recede, and by means of cunningly-designed shadows entirely change the architectural pattern of the studio.

The expert disclosed that the room they were in was the most intensely lighted in the world, being equipped for 23 watts per square foot as compared with 15 watts per square foot in the Cleveland Auditorium, where lighting engineers had specially planned for brilliant illumination as an aid to mass enthusiasm.

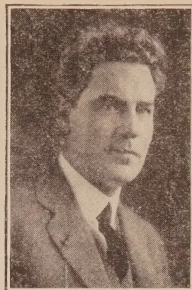
He explained that formerly designers were forced to imitate the lighting effects of nature, such as sunset, twilight, afterglow and moonlight. These were duplicated within the walls of the NBC studio, and then Dr. Luckiesh demonstrated the possibilities for creative imagination by the use of secondary colors. With the aid of these, reinforced by sunning shadows, he completely altered the architectural design of the studio from a cathedral to a severe Roman forum, and to a modernistic futurist design typical of the present day.

Dr. Luckiesh paid tribute to Raymond Hood, the architect of the National Broadcasting Company Building, who had evolved a design which adapted itself to the novel lighting system, and intensified the various effects desired. Further novelties were an effect of swift motion by "fountains of light" from giant chandeliers, and an impressionistic extravaganza he termed an "Eva Tanguay" effect.

The wizard of Nela Park also complimented M. H. Aylesworth, president of the NBC, on his vision in resorting to light effects for stimulating broadcast artists. Walter Demrosch and a symphony orchestra, with famous stars such as Galli-Curci and Maria Jeritz, have performed in the Cathedral Studio before a critical audience during nationwide broadcasts over the NBC System.

Dr. Luckiesh demonstrated that the NBC installation was a revolutionary departure from accepted methods, and predicted that it would pave the way to similar installations in giant theaters where lighting effects are under the supervision of artistic men.

At the switchboard for the demonstration was O. B. Hanson,



**In seven years
I have shown
7100 men how to
DOUBLE their salaries
—I can do the same for you!**

Seven years ago I was merchandise manager for one of the largest mail order houses in Chicago.

About that time radio was just getting started. Despite its crudeness, I believed that it would some day be one of the industrial giants in this country.

Knowing the problems of the automobile industry in its early days, I believed that I had a place in this coming industry—so I quit my job.

May 1st, 1922, I organized the radio company of which I am today president. My company was started with an entirely different idea about selling radios than any in use at that time.

What has been the result?

Today we are running two large factories in Chicago and have a sales organization of over 7100 men—factory trained service men who are making from \$25.00 to \$60.00 a week in addition to their present salary, because the majority of these men are giving me only their spare time—their evenings.

Seven years ago, my friends told me it couldn't be done—today, I'm willing to let the results stand for themselves.

You are interested in radio or you wouldn't be reading this magazine. Are you interested in making money out of radio? If so, you should know about my plan.

Can you spare two evenings a week? Will you do it if I can positively prove to you that in so doing you'll double your present salary?

Don't pass judgment until you have all the facts in front of you—make me prove my statements.

With or without radio experience, I can show you how to keep your present position and double your salary. You may think that radio cannot offer any such a possibility today but it does—the results of 7100 men, working under my plan, prove it.

First of all, let me say there is no other plan in radio today like this one. It is a sure and definite way to make money out of radio and it doesn't make any difference what the competition may be.

Don't forget this one fact—my plan is no theory—it is a fact, a working fact—and I'll give you the names and addresses of men who are with me. You can't dodge the fact that any plan, which enables 7100 men to make money in radio, must be sound.

You'll find my plan entirely different to any other—the result of seven years experience. Why not learn more about it—all you need do is to send for my 84 page book—THE WILL TO WIN.

In this book is the story of thousands of men and what they have done under this most unusual radio plan. Thousands are making from \$16.00 to \$24.00 a week in addition to their regular salaries. Hundreds are adding \$30.00 a week but you'll be amazed at how many are making better than \$50.00 a week and—

Remember, this is in addition to their regular salary.

Would this extra money be of interest to you—then send for this book—THE WILL TO WIN. You'll find it the most interesting radio book you have ever read.

Read the story of how I started my business with one helper and a stenographer. Let my book show you through my offices and factories today. You'll quickly see how successful this plan has been. Read the story of hundreds of men who are making good—yes, making big money in radio today.

----- Fill out the coupon now lest you forget it. -----
J. MATHESON BELL, 128 Austin Ave., Chicago.

Send me my radio book THE WILL TO WIN. Show me how I can double my salary with your plan.

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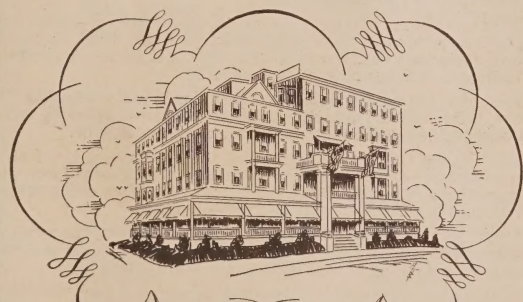


100% Comfort

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Rooms \$2.50 and up; with bath \$3.50 and up

NEW
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HOTEL CHICAGO
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A LEADING Hotel of this Popular Resort. Rooms—Single—Double or ensuite with private baths. Unexcelled cuisine and service. . . . American Plan. . . .

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• MARLBOROUGH HOTEL •

ASBURY PARK, N.J.
"ON THE ATLANTIC"

manager of plant operations and engineering of the NBC, with George McElrath, NBC operating engineer, and a staff of electricians.

Prof. S. K. Barrett, professor of illuminating engineering at New York University and chairman of the New York section of the Engineers' Society, presided at the meeting and introduced the speaker.

Remote Control System

REMOTE control is the next step in the advancement of radio receiving. Many of the engineers in the industry have been working on this problem for some years, but so far the ideal "remote control" has not been uncovered.

According to Joseph Attardo, of 77 E. 107th Street, New York, New York, the present affairs on the market will not answer the purpose, since they are not real remote control. According to this contributor a real remote control should have the radio set in some remote place like the cellar or a closet. He believes that his device, illustrated schematically and photographically on these pages, will be in demand.

Selector in Cabinet

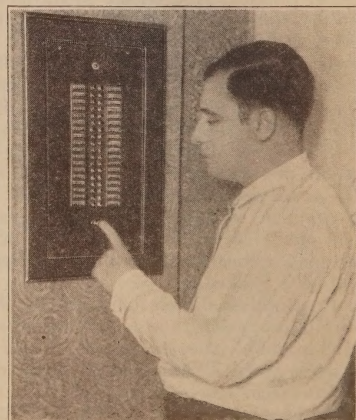
As shown in the photograph on page 118 the selector cabinet may be placed in the wall to suit the surroundings of that particular room. No expensive cabinet is required. Any number of speakers may be used.

A photographic illustration of the device on which patent application has been made by Mr. Attardo is shown on page 119. According to the designer the mechanism consists of a distributor, a small motor, a few gears and a set of relays. To attach the control device no changes need be made in the set itself. The remote control unit is workable on any tuning chassis on the market, provided the tuning is accomplished by a single knob.

Mechanical Operation

The actual mechanical operation of this remote control device may be followed by tracing a single operation by means of a diagram shown in Figure 1. The on-off switch is numbered 43. Let us suppose that we wish to listen to WADC, which corresponds to push-button 25. We first close the on-off switch. This allows current to pass into the motor, 15, which is geared direct to the condenser shaft of the receiver. With the motor driving the condenser we press down button 25. This closes the contact at 21 and as the rotating switch point, 18, connected with the condenser shaft reaches contact 19 the circuit is established leading to the solenoid 40.

The solenoid exerts a magnetic force on the level 52, which in turn opens the motor contact at 47 and stops the motor driving the condensers. At the same instant the action of the solenoid is transmitted through a lever 61 to the second set of contacts at 63, closing them. These contacts are in the loud speaker circuit and when closed permit the signal to actuate the reproducer. It will then be understood that by following this

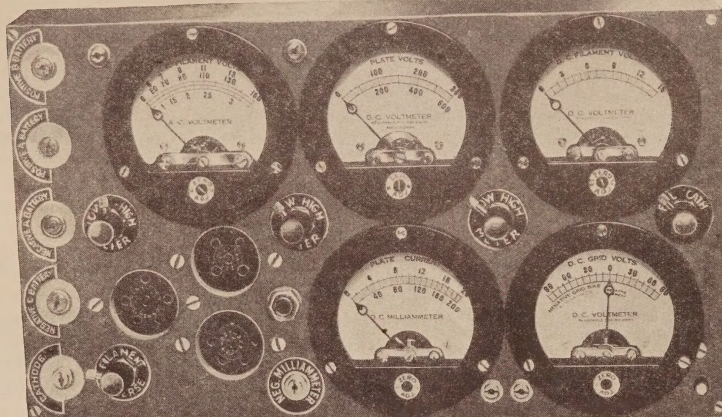


THE NEW HICKOK SG4600 SCREEN GRID RADIO SET TESTER

READS FILAMENT READS PLATE READS CONTROL
VOLTS HERE VOLTS HERE GRID HERE

The Only Tester that Indicates Simultaneously All the Constants of Screen Grid Tubes

Radio's Most Complete Servicing Equipment



Dealers' net price complete with carrying case

\$90.00

Write for FREE Bulletin No. 26

READS PLATE READS SCREEN
CURRENT HERE GRID VOLTS HERE

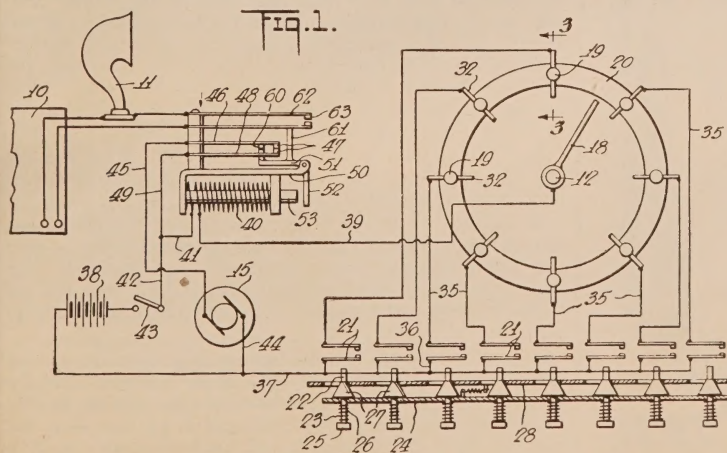
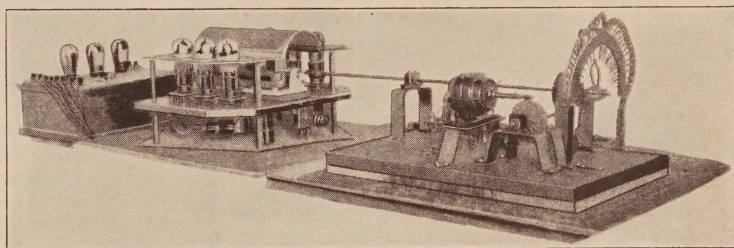
INDICATES SIMULTANEOUSLY ALL THE ABOVE VALUES

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

CLEVELAND, OHIO

sequence the station desired is accurately tuned in before the loud speaker is made alive. This does away with the unpleasant effect of passing through carrier waves of undesired stations.

After the switch is thrown and the condenser has been revolved to the proper point to bring in the desired station and the motor has stopped, the radio receiver continues to function on that particular broadcast station until another push button is actuated or until the on-off switch



is opened. If another program is preferred the only move is to select the proper button and push it. This automatically breaks the circuit on the first station, starts the motor and selector on its normal journey again which ends only when the new carrier wave is reached.

If the user is through with the set he merely opens the on-off switch which opens all circuits and apparatus but leaves everything in position for the next listener.

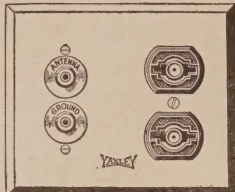
Reversing Motor

A means for reversing the motor when the plates have been rotated completely in or out of mesh has been found and is in the employment of a special relay which comes into play automatically at a predetermined point near the end of the scale. Of course if the old type condensers are used this relay is not necessary as the

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electrical outlet box or may be attached directly to lath or studding.

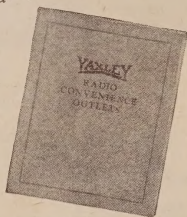
No. 135—For Loud Speaker.....\$1.00	No. 241—Aerial and Ground.....2.00
No. 136—Aerial and Ground.....1.00	and A. C. Connections.....\$2.00
No. 138—A. C. Connections.....1.00	No. 242—Loud Speaker and
No. 142—Two Loud Speakers 1.75	A. C. Connections.....2.00

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Volume - Controls - Resistances - Jacks
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plates have no end stops and can be revolved completely around.

In the installation used as a demonstrator by Mr. Attardo the volume is controlled by a variable resistance located near the particular speaker to which the operator happens to be listening. If there is more than one speaker in use the volume of each can be controlled independently of the others by any one of the numerous constant resistance devices now available on the market.

If an installation can be made while the house is under construction there is every reason for wiring the house for radio as well as light. The push button device being relatively inexpensive might be duplicated in all rooms where the radio should be controlled. Only one set would still be needed but a cable must extend from each panel of push buttons to the set itself.

KDKA Short Wave Receiving Station

THE listening post of station KDKA would be a dyed-in-the-wool radio fan's idea of Heaven. There, seated before three of the finest short wave receiving sets that engineers of the Westinghouse Electric and Manufacturing Company are able to build, he could listen to the high frequency stations of the world.

Holland, England, Australia, Java and other widely separated spots of the globe would all be within the reach of his delicately-tuned receivers. A polyglot program would be his. He would need to be a talented linguist to understand all he heard.

The present short wave receiving station of the Westinghouse Company is located on the William Penn Highway a short distance out of Pittsburgh and several miles from the KDKA transmitter in East Pittsburgh. It was established in 1928, although Westinghouse had done much short wave receiving work before that time. The small building that houses the sets, battery equipment and other necessary apparatus was erected in the fall of 1928 and checking of foreign stations began in October.

All the world has heard of some of the exploits engineered through this little station. Big Ben, the famous Westminster clock, has sent its deep tones to America via the short wave station and the KDKA transmitter. Holland, Germany and Australia have sent programs to the station which have been repeated for American listeners.

The KDKA listening post is equipped with three receiving sets. Two of them were built especially for the station. The other is of a type manufactured for the Government. The two special sets are so arranged that they can be hooked together and their incoming signals combined. At the same time the two are connected to different antenna sets. In this way, when the signal is fading on one set it may be full strength on the other. This makes possible more even reception.

Each set operates its own dynamic speaker. When the two sets which are used jointly have been tuned in satisfactorily their output is switched to a single speaker.

In addition to having three receiving sets the station has three separate antenna sets. Two are directional; that is, they will receive signals coming from only one direction. The other is a vertical non-directional antenna, of a type evolved by the Westinghouse Company in the early days of short wave work.

The two directional antenna sets are huge networks of wire suspended from wooden poles. The larger is 300 feet long by 80 feet wide and is hung 60 feet above the ground; the smaller is 150 feet long and 50 feet wide and is 20 feet above the ground. They are pointed toward England, Germany, Hol-

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1800 Sunshine Rooms (all outside)
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WARDMAN PARK HOTEL
Washington, D.C.

land and Italy in a Great Circle route. In other words, the direction is Northeast across Newfoundland.

So well do these sets carry out the intentions of their designers that they will not receive signals efficiently from Canada despite the nearness of stations there. Signals from Commander Richard E. Byrd's camp in the Antarctic are received through the vertical antenna.

One of the interesting phenomena of the art is the amount of time the waves take to go from one point to another. Of course this is very short, yet it is noticeable. One of the most common examples at the short wave station may be demonstrated by tuning in on KDKA with a regular broadcast band receiver, and on a California station broadcasting the same chain program. In this case the program from KDKA is approximately one-tenth of a second ahead of the same one received by short waves from the West Coast. This time lag is mostly in the wires from New York to the short wave station rather than in the air time from the west, it is explained.

One of the most interesting examples is explained as follows: England was celebrating the recovery of King George with an all-Empire radio program. This was broadcast by 5SW in Chelmsford. From there it went to a Canadian Station and then to Australia. KDKA engineers listened to the program, not from England or Canada, but from Australia. This meant that the program traveled approximately 3,500 miles to Canada, 10,000 miles to Australia, then 9,000 miles to Pittsburgh. At the same time another short wave receiver was turned in directly on 5SW. The time lag was very noticeable in this case, the program reaching Pittsburgh by the way of Canada and Australia sounding like an echo to the direct program.

Governor Grid Amplifier System

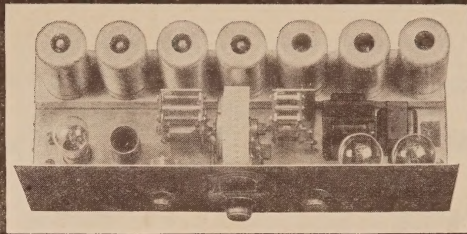
THE circuit shown in the schematic diagram accompanying this article is contributed by Vincent J. Fabian, 1717 17th Street, N. W., Washington, D. C. According to the contributor patent applications have been made on this particular circuit about which details are to be given in the following paragraphs.

According to the designer the coupling of the first two tubes is in every way unique. The grids are self biasing, no negative returns being used throughout and no C battery employed. According to a statement made by the designer the system is non-microphonic and the tubes cannot be made to oscillate internally or vibrate externally. The frequency response is said to be straight line where good transformer input is used and proper materials specified. According to the contributor the first two tubes receive a simultaneous signal. Both tubes amplify the initial signal. The amplified output of the first tube is superimposed upon the amplified stage in the second tube, which tube amplifies its own signal and the amplified input of the first tube. In other words, it is a first stage amplifier to the third stage tube and a second stage amplifier to the first stage tube. When the dotted-in resistor R-4 is used it also becomes still greater an amplifier by feeding back a portion of this combined signal upon both the first stage grids wherein it is utilized by these grids alternately in phase as in regeneration.

However, Mr. Fabian states this is not truly regeneration, as it is not fed back magnetically through a field feedback, but actual voltage, out of phase, is thrown directly in a physical circuit with a definite action.

According to an explanation made it is said that an incoming signal causes a change in internal resistance within the tube, the lowering and rise of I R drop permits the tube to leak off on one hand and become biased on the other. There is a great capacity in the circuit externally between the plates of these tubes and the grid. Internally the capacity is re-

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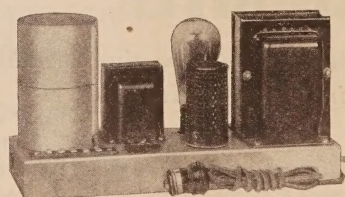
Such startling realism! Such unflinching accuracy. Its great power and sweet tone will thrill you. Its keen sensitivity and positive 10 Kilocycle selectivity will amaze you. With only a wire screen or metal base aerial built in the cabinet, **the Mastertone** gets distant stations sharply, clearly and distinctly over entire musical scale, with magnetic, dynamic or horn speakers, and without a bit of hum.

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All metal completely shielded chassis: 7x21x7½ inch. Fits nearly all consoles. 11 tubes operating at peak efficiency (5-224; 3-227; 2-245; 1-280). Single dial positive one-spot tuning; Humless AC Operation; Uses 5 Screen-Grid tubes, 5 Tuned R. F. Circuits; High Power Screen-Grid Detector, with 175 volts impressed on plate; Automatic line voltage control inbuilt holds voltage against fluctuating; 100-volt DC dynamic field supply incorporated; 3-stage phonographic amplifier; Finest quality precision made parts.

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Quality—not quantity—the H. F. L. Mastertone standard. One demonstration will convince you that it's the master receiver of all times. Fully guaranteed.



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Not an ordinary power pack, but a specially developed unit of the Mastertone, built separately to simplify installation. Has oversized transformer, full wave type 280 rectifier tube.

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*The Quick Method for Locating Trouble
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Accurate, Sure, Complete, Practical

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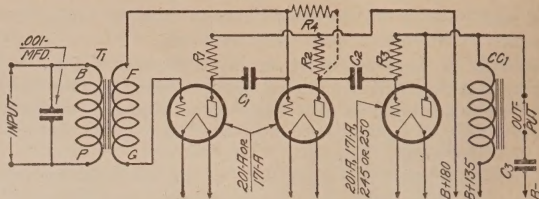


Fig. 1

moved. The larger capacity serves to isolate the d. c. proportion. The resistance between the grids and filaments is normally lower in operation and varies with the input in exact proportion to the input as this is the voltage amplifier.

While three stages are shown more may be used, the additional stages being coupled in the same method as in the third stage as shown. The theory of the last stage, according to Mr. Fabian, is quite simple. The resistor shunting the plate-grid is calculated at a mean to just bring this tube into a balanced position with the grid at zero. Thus there are two resistances between the grid and the plate. One a fixed resistance of from .25 to 10 megohms, depending upon the type of the tube, and the other the internal resistance of the tube, grid-plate. Capacity has been eliminated by the shunt resistor across this space but remains from filament to grid. There is an internal resistance from filament to grid which becomes materially lower in this arrangement. Thus the final balanced resistance internally in this tube is the square of the shunt resistor, the internal resistance of the tube grid plate in this condition, the elimination of capacity from grid to plate and the lowered resistance filament to grid.

Mr. Fabian says "the square will be found to be a semi-variable resistance from filament to plate, zeroed in the grid territory. An incoming a. c. sine varies the variable portion of the resistor in equal proportions at both halves. The fixed resistor, of course, remains constant. This is satisfactory for a normal operation and tubes in maximum operative state. Thus as the plate varies going negative and from positive to normal the internal resistance varies likewise, the shunt resistor maintaining grid at zero. When the plate varies the voltage drop across this resistor varies likewise and the voltage flows across it in an opposite direction and on the reversal it reverses and flows in opposite sine, out of phase. Thus again we have the voltage fed back to the grid."

According to the designer the constants of the circuit illustrated schematically in this article are as follows:

- R-1 non-inductive Lavite 75,000 ohm,
- R-2 non-inductive Lavite 57,000 ohm,
- R-3 5 to 10 megohms, 7,000,000 ohms average.
- R-4 2 to 5 megohms (R-3 and R-4 should be measured),
- R-5 Rheostat,
- R-6 Rheostat,
- R-7 with three tubes and using a Raytheon tube in the eliminator the value is about 1500 ohms. With two tubes approximately 2200 ohms is about the right value, wire wound type,
- R-8 Centralab 250,000 or 500,000 maximum.
- C-1 .005 to 1/10 mfd. or an average of .01 mfd.,
- C-2 the same as C-1,
- CC-1 for 201-A and 171 type tubes an output audio choke designed for the 120 power tubes is about right and not critical,
- C-3 3 to 5 mfd.,
- T-1 Amer-Trans DeLux.

Those interested in this particular circuit and wishing further information may secure it from the designer whose address is given at the beginning of this article.

Television—1930

An Analysis of Recent Television Progress and General Prospects for 1930

By JAMES W. GARSIDE

President, Jenkins Television Corporation

WHAT is the present status of television? That is a question paramount in the minds of radio fans today. People recalling how the automobile, telephone, radio, talking movie and other inventions developed from the laboratory to great industries, have been following television progress with more than normal interest.

Until a year ago, television was a subject of almost universal discussion. Today, one hears comparatively little about it, both in the press and in general conversation. Perhaps the best way to account for this reticence is to say that television is now looked upon in the cold light of a problem, rather than in the poetic vein of a glowing promise. A year or so ago, television workers fired with enthusiasm, were eager to expound the marvels that seemed practically within their grasp. They felt that the big job of achievement was done and that commercial application was the least of their worries—an after-thought to be speedily dispatched. But when they buckled down to real engineering development preparatory to actual production, they found that simple theory was easier than practice. Many became disillusioned and left the field entirely. Certain radio organizations, quickly convinced of the tremendous amount of pioneering still to be done, gave up all thought of immediate exploitation and assumed what may be termed a negative attitude. Those who remained in the field were thoroughly conversant with the multitude of technical problems yet to be overcome and, consequently, were those to overcome them first and talk later, which explains the lack of accurate information at the present time. Those organizations actively engaged in the development of television at present, are pushing ahead. They are making real progress. They prefer to talk of achievement rather than anticipation.

In television, as in radio broadcasting, the prime requisite is the transmission of suitable program material. Refinements in receivers and receiving practice will keep pace as a matter of course. In substantiation of this, it will be noticed that of the organizations actively engaged at present, practically all operate transmitters of some sort. In our own case, that is to say, the Jenkins Television Corporation, we have found it expedient to operate several transmitters continuously, while developing the embryo receiver or radiovisor into a practical instrument of home entertainment.

One of our transmitters, Station W2XCR, is located on the roof of our production plant in Jersey City. A second transmitter, Station W3XK, is located in Montgomery County, Maryland, just outside of Washington, D. C. Both stations are licensed for outputs up to 5 K. W., and, due to the efficiency of short waves, have a wide coverage.

At present our programs for the most part consist of "radio movies" or animated cartoons, following the ideas of C. Francis Jenkins, television pioneer and our vice-president in charge of research. The shadowgraphs or animated cartoons are permanently recorded on standard motion picture film. The film is run through a pick up device resembling a standard motion picture projector, and, in the case of W2XCR, broadcast on a wave length of 107 meters. This wavelength, incidentally, was recently changed from 139.5 meters by authority of the Federal Radio Commission, to avoid interfering with other television broadcasters. Simultaneous with the new wave length change, the Jersey City transmitter has been materially improved. To begin with, a new transmitter has been designed and put in operation, which will enable us to obtain 100 per cent modulation of the carrier wave over the 30 kilocycle side band width. This will provide detail for our images and will

HERE'S YOUR **AMATEUR CALL BOOK** ON SALE NOW!



NEW AMATEUR CALLS have been assigned in many countries. Due to the adoption of the new Prefixes, many lists of amateur calls have been changed completely. Radio AMATEUR Call Book for December, 1929, is the ONLY publication giving latest correct information on these calls. The issue also includes hundreds of U. S. and Canadian amateur calls just recently assigned.

We were sold out early on the September issue, so use the coupon and get your big DECEMBER number NOW.

NEW PREFIXES now in use by amateurs in all parts of the world. You need this issue to identify stations heard, as the old Intermediate system has been replaced by the new Prefixes, such as D, OA, X, ZS, etc. We have the most complete list published.

WHO'S WHO ON SHORT WAVES

A brand new section, giving frequency, call, and location of commercials, shortwave fones, television stations, etc., to be heard between 3,000 and 30,000 Kilocycles. Amateur bands are shown in heavier type, so that you can quickly find stations heard above and below the various bands.

Lists published elsewhere are no longer reliable, due to many changes in call letters and shifting of commercial frequencies. This is THE LIST you have been waiting for, giving hundreds of stations heard nightly all over the world.

Radio AMATEUR Call Book, Inc.
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Here's my \$3.25 (Outside U. S. and Canada \$3.50) for the September, December, 1929, March and June, 1930, numbers. Single copies \$1.00 (Foreign \$1.10).

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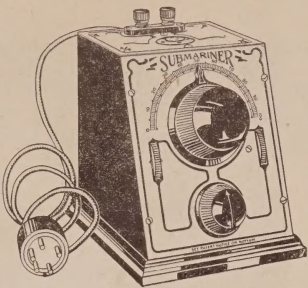
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SHORT WAVE

With Your Present Receiver

Experience reception on short waves, by attaching a "Submariner" to your present receiver, whether AC or DC. There is a model for every need and requires no changes of any kind to your receiver. Only a few seconds is required to attach or detach.

Users of "Submariners" in U. S. hear England, Holland, Germany, Australia and many other distant countries broadcasting. In addition to hearing broadcasting from these far countries, thousands of code messages have been received from every part of the world.



THE SUBMARINER

has been sold in all parts of the world since 1926 and is not only a pioneer, but with its many improvements is adaptable for use with all receivers, including 1929-1930 receivers on which ordinary adapters will not work. The "Submariner" will give results equal to any short wave receivers at only a fraction of its cost.

Prices: Regular model, fixed wave band 16-32 meters, AC or DC, \$17.50. Regular model, interchangeable coil 14-150 meters, AC or DC, \$22.50. The "J" feature, an exclusive "Submariner" achievement, gives five times the volume of any other adapter. Price: Fixed wave band 16-32 meters, "J" feature, \$22.50. Interchangeable coil, 14-150 meters, "J" feature, \$27.50. In ordering, give model of set and numbers on tubes in it.

Will be sent prepaid on receipt of price, or C.O.D.
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J-M-P MFG. CO., INC.

3433 Fond du Lac Avenue

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greatly facilitate the transmission of half-tones. The power of the transmitter has also been increased to the point where advantage can be taken of the full output allowance. A regular schedule of transmission has been arranged, and the station is on the air on week days from 3 to 5 in the afternoon and from 8 to 10 at night. The Washington transmitter, W3XX, also maintains a regular schedule, broadcasting from 8 to 9 P. M. on week days. Both stations operate at the maximum power allowance consistent with minimum interference with other radio services.

The Jenkins programs consist of vocal announcements, explaining the picture to follow and what adjustments should be made if certain characteristics are present. Thus if a certain portion of the picture is white instead of black, or if it is streaked or spotted, or if certain details fail to appear, the receiving operator knows what to do. Following this, a number of specially prepared animated cartoons such as prize fights, domestic comedies and so on, are broadcast. By this time the receiving operator should have his apparatus properly adjusted. A reel of standard moving picture film with half-tone detail, is next transmitted. It will usually be found that this does not come in quite as clearly as the animated cartoons, for several reasons. It is, of course, far more complicated to transmit, but the chief drawback is to be found in the short-wave receiver used in conjunction with the home radiovisor. Most of these receivers are of the regenerative type and consequently have a frequency cutoff of about 3000 cycles. Incidentally, we are working on the development of a short-wave receiver that will be non-regenerative yet powerful enough to intercept fairly distant or weak signals. The problems confronting us in this task can be readily appreciated.

In the past year we have made a number of important improvements in our commercial home radiovisor. Jenkins radiovisors have been set up at various points in the field with a view to checking the operation of the transmitter. Many interesting effects have been achieved by means of the radio road tests, so to speak, and considerable progress in transmission as well as reception is directly due to our findings.

Among other improvements, we might mention the erection of a vertical, non-directional aerial at station W2XCR. This aerial consists of a copper mast 110 feet high, located on the roof, operating in conjunction with a counterpoise ground. The copper mast antenna comprises a number of sections of corrugated copper tubing such as is used for leader pipe on the outside of buildings, reinforced with soldered brass bars and joined together with wooden plugs. The vertical antenna thus formed is guyed in all directions and reinforced with wire bracings so that it cannot buckle or collapse. The copper mast rests on an insulated platform. Connection to the transmitter is made at the bottom of the mast. The resultant antenna system, being a single vertical conductor and radiator, is absolutely non-directional, which is most desirable for mass communication or broadcasting. The ground equivalent is in the form of a counterpoise made of many parallel wires supported a few feet above the roof, and surrounding the base of the copper mast antenna. The efficiency of this system has been attested by television lookers-in in Chicago, who report nightly reception of the radio movies.

Inductive interference is the bane of the television broadcaster. The most intense measures must be taken to eliminate it. In radio broadcast reception, interference of an electrical nature is not pleasant, but at least it does not render the program indistinguishable. In television, however, interference makes itself manifest in the form of streaks and smears. We have found it necessary to shield everything in our transmitting stations, and, to this end, not only are the various circuit components enclosed in aluminum and copper shields, but entire units, operators and all, are enclosed in copper mesh

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False Economy Is Costly

Nothing is likely to prove as costly as a cheaply made, over-rated condenser or resistor.

Whether you are a manufacturer, professional set builder or experimenter, you cannot afford the high cost of a cheap condenser or resistor.

Aerovox condensers and resistors are conservatively rated and thoroughly tested. They are not the most expensive, nor the cheapest, but they are the best that can be had at any price.

A Complete Catalog with illustrations and detailed descriptions may be obtained free of charge on request.



The Aerovox Research Worker is a free monthly publication that will keep you abreast of the latest developments in radio. Your name will be put on the mailing list free of charge on request.

AEROVOX WIRELESS CORP.

72 Washington Street, Brooklyn, N. Y.

PRODUCTS THAT ENDURE

cages. All the critical conductors are copper sheathed as well, and the entire assembly grounded.

In the matter of television receivers, we feel that with the advent of some 12 to 15 transmitters in the television field, broadcasting experimental programs, the interest in home television is bound to increase rapidly. Accordingly, there will be need not only for a complete television receiver for those who do not understand or care to undertake the construction of such a receiver, but also for a moderately priced and practical kit for assembly by the experimentally inclined.

With such requirements in view we have developed a simple radiovisor, completely built and ready to operate, that will be made available to the public very shortly. In addition to the complete radiovisor, we shall provide a practical television kit or set of matched parts, with which any handy man or boy may make a satisfactory receiver. This kit will contain all the necessary parts such as scanning drum, neon tube, and an ingenious form of synchronous motor.

Because of the relatively poor results obtained with the usual short-wave receiver, particularly with half tones signals, we are developing a non-regenerative short-wave receiver which will eliminate distortion caused by regeneration as well as the 3000 cycles as in the usual type.

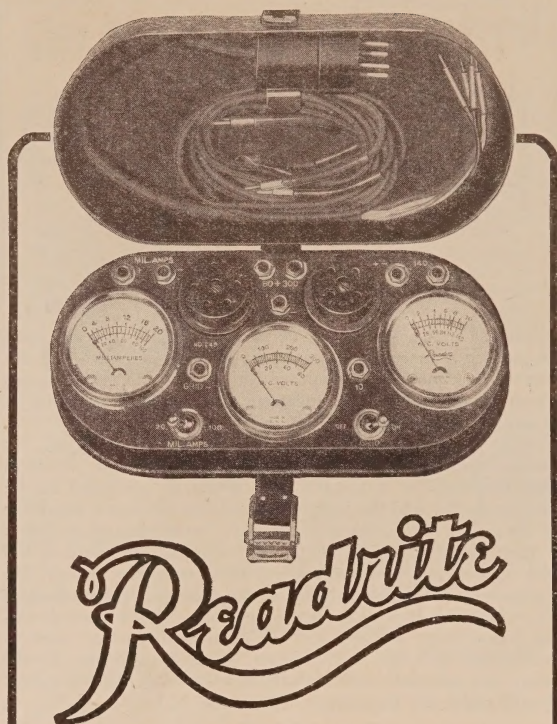
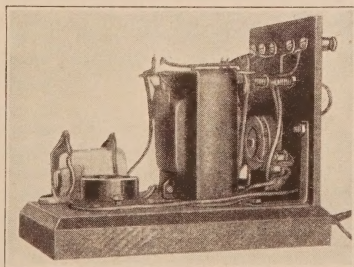
From the foregoing it is evident that television is making genuine progress. Nothing spectacular—no world-rocking developments—but good steady headway, based upon the sound experience of actual practice and many disappointments. It must be realized that television has a long way to go. It is heartening knowledge, however, that it is getting there slowly but surely, and has reached the stage where it may be offered to the public.

We grew up with radio. So shall we grow up with television. We believe it sound, therefore, to state that 1930 will see many thousands of radio enthusiasts in the United States enjoying the novelty of this art. Figuratively, these television fans will remind us of the pioneer radio listeners with headphones and crystal detector, enjoying, building and contributing to the progress of the young science. Thus we may hope in several more years to have television in the hands of the uninitiated, non-technical, average man, solely on its merits as a medium of home entertainment, when it shall be incorporated with the sound broadcast receiver for complete radio enjoyment.

Speech Amplifier Attachment

THE speech amplifier attachment described below is a contribution of Karl F. Oerlein, of Fred F. Oerlein & Son, radio service specialists, 1246 N. 12th Street, Philadelphia, Pa. Mr. Oerlein says he has found the device very convenient and handy and thinks that it might be of interest to readers of our magazine.

It is often found desirable to amplify speech such as in public address systems. The expense of a good address system often prohibits its use, as the cost usually runs to several hundred dollars. Here is an attachment which will perform in a first class manner and can be constructed for less than fifteen dollars. Its volume and clarity depend solely on the audio amplifier of the radio with which it is to be used. Most modern sets will give good



Model 245

SET AND TUBE TESTER

List Price \$20

Tests Screen-Grid

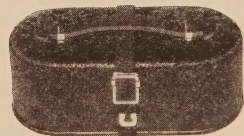
A SUPERB new model especially designed for A sets using the 245 power tube. Simple to use. Easy to carry. Supremely practical. Extra cords with tip jack connections, permit use of each meter individually. Checks line voltage.

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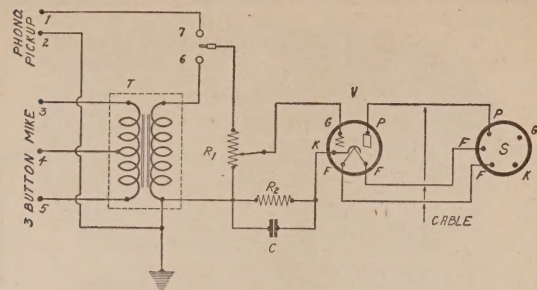


Fig. 2

volume as well as clarity. The uses to which this device may be put are numerous, especially in schools, churches and the home. In schools it may be used for class nights, small dances where an occasional announcement is to be made, socials, or at any public gathering.

Many modern electric radio sets are now equipped for phonograph reproduction. By means of a telegraph jack it is only necessary to insert the plug which is connected to the pick-up device into the jack. This utilizes the audio amplifier of the radio. It is, however, generally unsatisfactory to insert a microphone such as a telephone transmitter in place of the pick-up because the impedance of the transmitter is very low compared with the impedance of the tube or the transformer into which it is to work. Hence, an external impedance matching transformer is necessary for good reproduction when a microphone is used. The primary of the transformer should match the impedance of the microphone while the secondary should match the impedance of the tube.

Constants Shown

A description of the constants appearing in the schematic diagram, Fig. 2, is as follows:

Terminals 1 and 2, connection for phonograph pick-up, throw switch to 7.

Terminals 3 and 4, connection for single button microphone; throw switch to terminal 6.

Terminals 3, 4 and 5, connection for double button microphone, throw switch to terminal 6.

T is a microphone transformer, Silver-Marshall No. 242.

R-1 is a volume control, Electrad Royalty 200,000 ohms.

R-2 is an Electrad grid suppressor of 1500 ohms.

C is a Tobe 200-volt $\frac{1}{2}$ mfd condenser.

V is a 227 detector tube, while S is the base of an old detector tube with five prongs.

The device is simply an arrangement whereby an impedance matching transformer is inserted between the microphone and the detector tube of the set. If the set is not already provided with a phonograph pick-up jack this arrangement will make it available. Even if the set has a pick-up arrangement it is usually connected after the detector tube and since this device makes use of the detector tube, a much greater amplification is obtained from the set.

Either a single button hand microphone or a double button studio microphone can be used. To change from microphone to records one need only thrust the jack from 6 to 7. This is so quickly done that it is possible to intersperse record playing with announcements.

Parts Needed

The parts used in the writer's device were as follows:

- 1 Silver-Marshall No. 242 microphone transformer
- 1 UY socket, Eby
- 1 Electrad Royalty 0-200,000 ohms volume control
- 1 Electrad grid suppressor—1500 ohms
- 1 $\frac{1}{2}$ mfd condenser—Tobe, 200 volts
- 2 Phone tip jacks
- 1 Phone tip

5 Binding posts

25 feet rubber covered hook-up wire

1 4 x $4\frac{1}{2}$ x 3/16 wood panel

1 base of burned-out detector tube

See Music Waves Produced

BY means of a new device, known as the projection osiso, it is now possible for singers, speakers, actors, pianists, violinists, and other vocal and instrumental artists to see the sound waves they produce dance visibly across a screen, just as they dance invisibly through the air to the ears of their audience.

This device was developed by C. Anderson, engineer of the Westinghouse Electric and Manufacturing Company, Newark, N. J., in collaboration with William Braid White, acoustic engineer of the American Steel and Wire Company, a subsidiary of the U. S. Steel Corporation, who is using it in a series of studies of musical sounds at Steinway Hall with the co-operation of Messrs. Steinway and Sons. It consists of several different parts. The sound waves are caught by a microphone, which can be placed in any convenient location, and are conveyed electrically to an osiso, which consists essentially of a delicately suspended mirror that is oscillated in unison with the received sound waves. A beam of light, directed on this mirror, is reflected by it to a system of revolving mirrors, which, in turn, project it upon a screen where it can be viewed by any number of people.

When all is quiet around the microphone, a long white line is seen on the screen, but as soon as any kind of a sound reaches the sensitive electrical ear, the white line on the screen is thrown into waves, much as a clothes line is thrown into waves when its end is shaken. The form of these waves varies with the sound producing them, and they range from gentle ripples, produced by low pure tones, to the most intricate of patterns produced by loud complex cords and noises.

"Two practical investigations are now being carried on with the aid of the projection osiso," stated Mr. White, "although its possibilities seem almost endless.

"In the first place, we are using it to study the construction of pianos and other musical instruments in order to improve them. You need only watch the waves formed on the screen to notice that when I strike successive keys on this piano, though I strike each with approximately the same force, some notes produce distinctly larger waves than others. This means that those particular notes produce louder sounds than the rest due to some peculiarity in the construction. Your eye can see it although, if you are not a musician, your ear may not detect the difference. Secondly, when I strike various notes and then hold the loud pedal down after each, you can readily see that the vibrations last longer in some cases than they do in others, which shows that the sounding board reverberates better at some points in the scale than at others. Such characteristics, together with others which only an expert would notice, are investigated when once detected, and in due course eliminated.

"Another application of this instrument," continued Mr. White, "is to help the student improve his technique. The sound waves produced by the touch of a master pianist differ from those produced when the same keys are struck by an unskilled hand. Permanent records of the wave patterns produced by such distinguished musicians as Harold Bauer, Rudolph Ganz, Ernest Schelling, Josef Lhevinne, Mischa Levitski, Olga Samaroff, John Powell, and others have been made by means of the older photographic type of Osiso in the acoustical laboratory of the American Steel & Wire Company at Chicago, and, with these before him, the student can endeavor to reproduce them on the screen of the Projection Osiso. It seems certain that improvement can be attained in this way, but it also seems certain that no amount of effort will transform a good clerk into a great artists, for one of the

things that the Osiso has demonstrated is that each artist produces patterns as individual as his signature, and though others may be able to imitate these patterns fairly well, as a good forger can imitate a signature, apparently no one else can reproduce them exactly. The artist's personality, therefore, remains the principal element in the secret of the power he exerts over his audience.

"Obviously, however, the grosser errors in playing, singing, and speaking can be overcome with the help of this instrument, since, with the eye to aid the ear, an error can be more readily appreciated and its correction effected.

"Master musicians are also interested in studying the details of their own technique. For example, one well-known pianist has learned by osiso sound-wave photographs that he can produce a single note with at least 18 different gradations, each individual both in tone color and loudness. He can thus determine the actual difference between his 'cantabile' and his accompanimental notes, between his 'forte' and his 'Fortissimo,' and so on. Though great artists are in many ways beyond instruction, they nevertheless gain much from accurate information as to their own work, and the osiso is capable of showing them many things that have heretofore escaped direct observation. To mention one small detail, we were able to show one musician that his finger nails made little clicks when he struck the keys in a certain way, and though he probably never realized that fact, this certainly had an effect, however minute, on his playing, whether favorable or unfavorable is something for him to determine."

Mr. White's chief interest lies in the improving of wire for musical instruments, since the American Steel & Wire Company is a large producer of wires for pianos and other instruments, but in order to distinguish between effects produced by the artist and those due to the construction of the instrument, he has been compelled to analyze the work of artists and is thus laying the foundations of a new method of art study.

The osiso in its older form, which is suitable for photographing waves and for scientific work, has been used extensively in a wide variety of electrical and acoustical investigations. It is, for example, the instrument used by Byrd's radio experts on the Antarctic Continent in their study of the behavior of radio waves, and it is also being employed by Dr. Max Goldstein for instructing the totally deaf to speak correctly. The present development, by magnifying the wave forms to any desired extent, enlarge its range of usefulness, especially in the educational field.

Theremin Produces Musical Tones by Beat Frequencies

(Continued from page 56)

be found in Figure 3 which is another of the Theremin devices, similar to an electrical cello. The instrument is played on by means of a finger board and the volume of the tones is controlled by a lever. The instrument is built for volume exceeding that of an orchestra.

Still another combination is the one shown in Figure 4 which is a combined radio receiving set and a theremin device. The photograph in Figure 4 shows the internal construction of the device.

There is practically no limit to which the principles laid out by Dr. Theremin can be carried. It would not be very difficult to visualize in the future an entire orchestra made up of electrical devices producing musical sounds, the performers being able to duplicate tones not possible with the ordinary instrument.

Generating Sounds

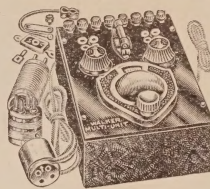
According to the patent application the invention relates to sound generating apparatus or instruments of the type em-

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One of the most unusual radio instruments ever devised. Will perform any individual function of a complete receiver, and in addition, may be used for calibrating, testing or checking. Makes a wonderful broadcast receiver, short wave receiver or transmitter. Oscillates violently over the entire scale range from 550 meters down to 15. Uses all tubes 199 to 210 and all voltages, A.C., D.C., or rectified.

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Serves as either an extra stage of tuned radio frequency or short wave adapter, by merely plugging into one of the tube sockets of the receiver. Tools or radio knowledge not necessary. The complete unit including four-lead plug-in adapter, plug-in coils, screen grid cap clip, etc., is housed in an attractive case, neatly finished. Complete non-technical instructions furnished. Box measures 7½x5x3½ in.

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Radio Magazine Editor

About the Multi-Unit

Read What Enthusiastic Multi-Unit Fans Say—

"Using my Walker Multi-Unit for about 5 hours today and among others picked up was one Short Wave station at Paris, France."—Geo. H. Keller, 267 Delaware Ave., Albany, N. Y.

"Purchased one of your Multi-Units and am very pleased—using it as an Extra Stage of R.F. at present. I have found it to be a very good Short Wave Unit."—R. L. Colosky, 1032 Clackamas St., Portland, Ore.

"I bought a Multi-Unit and it's great. I am getting stations I never got before—it cuts down static."—James Woodrow, 2132 Lloyd St., Milwaukee.

"I have one of your Multi-Units. It worked fine. I got your town, Dallas, Chicago, Salt Lake City, Winnipeg."—Frank Becker, Box 36, Russell, N. Dak.

"Your Unit is wonderful. Lots of pleasure picking up Short Wave Broadcasting with unit applied to an old 6-tube Freshman."—Ed. H. Ehrhman, 4740 Greenwood Ave., Chicago, Ill.

"I got a Walker Multi-Unit from you some time ago. I am very well pleased."—A. L. Demers, 2017 Alien Drive, Montrose, Calif.

"Have one of your very remarkable Multi-Units, and I wish to say that it has performed wonderfully. It works exceptionally well on Short Waves."—C. Hendon Baxter, 658 Marine St., Mobile, Ala.

"As a Radio Frequency Amplifier with a 199 tube, it certainly performed beautifully and added a lot of power to the Radiola 20."—Robert S. Alter, Cincinnati, Ohio.

"Have received Amateur Phone Stations, also Short Wave Broadcasts from KKKD, WLS, 2XZ (WABC), and 2XAL. Also heard WOO on board the 'Leviathan' talking to WSPN. Received this with sufficient volume on loud speaker to be heard in next room. Absolutely clear, no squeals, or hand capacity, I am more than pleased with the Unit."—A. E. Colton, 622 Evergreen St., Ashland, Ohio.

"Received several Short Wave stations right off the reel. I expect to receive Europe."—Patrick Curry, 203 14th St., Jersey City, N. J.

"I have been using your Multi-Unit as a one-tube receiver, employing a 201-A tube with very good results."—Nathan Edwards, 3453 Indiana Ave., Chicago.

"Your Walker Multi-Unit is a wonder in Radio achievement. I wouldn't take \$25.00 for mine if I could not get another."—Wm. Hoerner, Route 6, Kingfisher, Okla.

"I use the Unit as an R.F. Booster and the results are wonderful. Distance comes in like locals."—S. F. Kisco, 7511 Ridgeland Ave., Chicago, Ill.

"I have one of your Multi-Units and it has done everything as you have stated. I have also used it as a Modulator Oscillator and it has done as good as higher priced equipment. As a Short Wave with my Atwater Kent it reminded me of old times. The Radio Public don't know what they miss."—James M. Griffin, 2426 Fairview Ave., Wichita, Kansas.

"The 'Booster' works fine. I have been able to get a lot of stations in the daytime that I could not get before. Tried the one tube arrangement and can get WLW and WENR (Chicago)."—Edw. A. Schneider, 416 Capitol Bldg., Harrisburgh, Pa.

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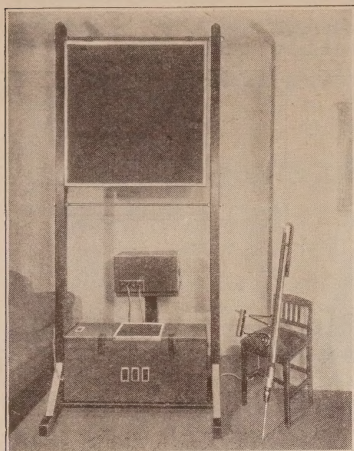


Fig. 3. In this photograph may be seen another electrical instrument which produces sounds similar to the Theremin. This is, however, an electrical cello which is played upon by a finger-board. This was designed to produce a volume far in excess of an orchestra

bodying an electrical vibrating system. It aims to provide a novel method of and means for producing sound in musical tones or notes of variable pitch, volume and timbre, in realistic imitation of the human voice and various known musical instruments. One object of the invention is to provide a simple and inexpensive instrument capable of producing musical tones according to the method embodying the same, the pitch, volume and timbre sounds may be varied over a wide range, and with delicate gradation.

An instrument embodying the invention comprises a sound receiver, such as the telephone receiver or loud speaker, connected to an oscillating system adapted to be controlled or effected by an object or objects, such as the hand or fingers of an operator held in relative position in proximity to an element of the system. For example, an electrical oscillating system including oscillator tubes of the electro-ionic type may be employed, and the circuits of the system may be so correlated that the frequency or frequencies of the electrical oscillation will vary in accordance with the variations in the electrical capacity or other characteristics of the controlling circuit caused by the movement of external objects such as an operator's hand or fingers as above stated. The operator's hands, or the objects moved by him are not required to make physical contact with the instrument, but if the instrument is arranged to permit such contact the generation or production and control of the sound is not affected directly thereby as is the case with the ordinary musical instrument.

Two Oscillators Used

In order to generate clear sound or musical tones and permit ready control thereof, a plurality of oscillators are employed, having a frequency above the audible range but interacting with each other to produce interference or beat notes of audible frequency. The frequency of one or more of the oscillators is controlled by the operator to produce beat notes of the desired pitch. The apparatus in preferred form also embodies means for controlling the volume and timbre of the music.

The improved method and means of this invention producing sound or musical tones possesses great advantages over ordinary musical instruments of the prior art. Apart from the simplicity in construction and operation of an instrument embodying the invention, it is capable of producing clear and pure musical tones in realistic imitation of a known instrument, such as the violin for example, and may be so constructed that the characteristics of the sound or music produced thereby may be changed as desired in imitation of various other instruments, whereas the ordinary musical instrument such as the violin produces sound tones of fixed and well known characteristics. The instrument is not limited,

however, to the production of music but may be employed to generate sound or operate signals for various purposes.

Other Objects

Other objects and advantages of the invention particularly with reference to electrical elements and circuits and their arrangements in systems for securing various results in different constructional embodiment which have been devised, will appear from the following description considered in connection with the accompanying drawings in which are shown several modified forms of the invention. Various practical embodiments of the invention are hereinafter described in order to make a full and complete disclosure, but the invention obviously is not limited to the specific arrangement shown and it is to be understood that no limitations thereon are intended beyond those set forth in the appended claims.

Numerous Elements

A preferred form of instrument embodying the invention and operable according to the method of embodying the same comprises the following elements:

A control element or electrode with relation to which an object such as the hands or fingers of an operator are moved to control the pitch and the character of the sound tones emitted by the instrument. Said element does not function like the antenna in a wireless receiver or apparatus, i. e., it does not receive or detect radiant energy transmitted from a distant station, but has a novel and radically different function that will appear from the details in connection with the various circuit arrangements.

Oscillating circuits adapted to produce one or more deep notes of audible frequency.

Means for regulating the volume of the sound tone.

Means for switching individual sound tones on and off as desired.

Means for controlling the timbre of the sound tones.

Means for eliminating or nullifying the natural oscillations of the amplifier or reproducer to prevent the production of undesirable noises or distortion of the sound tones.

In broad aspect the means of the invention comprises an oscillating system capable of producing audible sound tones and adapted to be influenced or affected by an object or objects such as the hands or fingers of an operator moved in proximate relation to an element thereof, together with a sound reproducer operatively connected to some system. Stated differently, the invention embodies a method and means for producing sound or musical tones characterized by an oscillating system in which the period is varied and the characteristic sound emission from which is changed by the movement of an object or objects in proximate relation to an

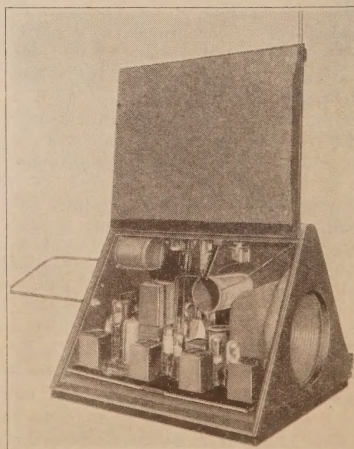


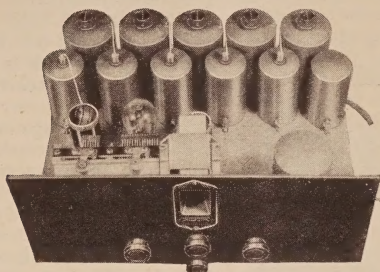
Fig. 4. Another extension of the Theremin idea is depicted in this picture where the reader may see the internal construction of a combined radio receiving set and Theremin. The loop at the left is one of the control elements while the rod extending upward at the right of the raised cover is the other controlling electrode, one being for volume control and the other being for tonal control

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element thereof. The said system may be electrical and so arranged that movement of an operator's hands or fingers will change the electrical characteristic thereof such as the electrostatic capacity between certain elements which determine the period of the oscillator. It is obvious that other types of oscillating systems and other means of control may be employed to accomplish the same results.

Above Audible Range

The oscillating frequencies of the oscillators are preferably above the range audibility but are nearly the same so that the interference frequencies produced in the circuit of the tube will be relatively low and produce a deep note of audible pitch in the loud speaker. The frequencies of vibrations in the circuit of the tube may be called audible frequencies as they will have substantially the same number of vibrations as the vibrations of an audible sound wave. The pitch of this note and the presence and strength of the overtones are controlled by selection and arrangement of the condensers, inductances and other elements in the circuit in a known manner.

The frequencies of an oscillator may be of the order of 500,000 cycles per second, the precise frequency being so chosen that no interference with broadcast reception is produced. The values of inductance and capacity employed in the oscillating circuit are selected in accordance with well known principles to provide the desired frequencies and the variation of the capacity of the variable oscillator is affected by the change of capacity of the control electrode which change in capacity in instruments that have been built is of the order of 10^8 — 10^9 microfarads. It will be understood that this change in capacity affected by external control is so

correlated with the capacity in the oscillator circuit that the resulting range in pitch of the musical instrument covers several octaves.

The sound generated in and emitted through the loud speaker is also controlled by the movement of an object or objects such as an operator's fingers in proximate relation to the electrode or control element which is connected to the oscillating circuit and to the grid of the oscillator. The electrical characteristics of the set control element influence the period of frequency of the oscillator and the character of the deep note in the reproducer. As the operator's fingers are moved in suitable relationship with set control element the pitch of the deep note in the reproducer is varied and continuous variation may be produced with most delicate gradations for the continuous movement of the fingers.

Capacity Changes

This control is primarily the result of a change in the electrostatic capacity between the control element and the ground potential, or between the control element and the other elements of the circuit. Therefore, it is obvious that other objects than the operator's fingers would be operable to vary the tone produced. Furthermore, it will be appreciated that the amount and direction of the controlling movement will depend somewhat upon the dimensions and arrangements of the control element which may be of such character that movement of the fingers to the extent required to play an ordinary instrument such as the violin, will produce a corresponding effect and note change in the present sound generating instrument, so that one who has learned to play the violin or some other instrument will have little difficulty in playing the present instrument.

Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

Lincoln DeLuxe Ten Now Using Five Tuned Intermediate Stages

(Continued from page 53)

Tuning the Primary

After determining that the primary of the transformer be tuned there is still left one remaining possibility, namely, tuning both the primary and secondary. Tuning the secondary, of course, would eliminate the short circuiting effect of the input capacity of the tube. When both the primary and secondary are tuned a maximum transfer of energy no longer takes place with close coupling. The condition for maximum transfer of energy, to the contrary, a very loose coupling. Since space limitations eliminate the possibility of separating the primary and secondary by a space of 6 or more inches, depending upon the type of coil used, it was necessary to run one of the coils so that it was practically at right angles to the other. It was found, however, that there is no such thing as perfect shielding. The gain which can be obtained with the tuned primary transformer is more than can be successfully used. The tuned primary transformer gave a gain of 75 per stage at a frequency of 475 kilocycles with complete copper shielding and by-passing. It was found, however, that this gain had to be reduced for stable operation. For this reason the tuned primary and secondary transformer was found to offer no advantages, from a standpoint of the amount of amplification which could be used in the set, and, had the distinct disadvantage of an additional adjustment for each stage.

The consistent performance of this new receiver has entirely revolutionized the designers' ideas of the possibility of radio reception. The high noise level in the past has made this distant reception very unpleasant to listen to, and the high amplification in the Lincoln DeLuxe 10 with ability to tune below the noise level, and, at the same time, its extreme selectivity allowing every channel to register, has come closer to producing the ideal receiver.

A. C. Self-Modulated Oscillator May Be Help in Servicing Sets

(Continued from page 108)

device for maximum deflection of the meter. When this condition is had the receiver is in line. This point of adjustment should be checked at approximately two places on the dial, some place preferably near 700 kilocycles and 1200 kilocycles.

Parts Used

The list of parts as used in this tester was:

- 1 Hammarlund aluminum shield
- 3 X-L type G-5 vario-densers
- 1 Hammarlund 50 m. m. f. midget variable condenser
- 1 Frost 1000-ohm rheostat
- 1 Benjamin 9040 4-prong socket
- 1 10-watt 110-volt lamp
- 1 Standard porcelain base receptacle
- 1 Silver-Marshall No. 121 shielded .00035 coil
- 1 Thordarson 2902 transformer
- 1 Frost 30-ohm rheostat
- 1 Jewell pattern 64 current squared thermo coupled galvanometer
- 1 General radio switch arm
- 3 General radio switch contacts
- 1 Bakelite panel to fit
- 3 Eby binding posts

S-M 722 D. C. Now Designed For Use on Batteries With High Gain

(Continued from page 51)

- 1 Silver-Marshall 30X selector coupler
- 1 Silver-Marshall 122 shielded r. f. coil
- 2 Silver-Marshall 123 shielded r. f. coils
- 1 Silver-Marshall 275 r. f. choke
- 1 Silver-Marshall 270U push-pull input transformer
- 1 Silver-Marshall 258S push-pull output choke
- 1 Silver-Marshall 818 hook-up wire
- 3 C-R 222 tube sockets
- 3 C-R 112A tube sockets
- 2 Potter 30B condenser blocks
- 1 Polymet .006 large moulded condenser
- 1 Polymet .00015 condenser
- 1 Polymet .0005 condenser
- 1 Yaxley 10 MJP 10,000 ohm potentiometer
- 2 Yaxley 422 insulated tip jacks
- 1 Carter 2A closed circuit jack
- 3 Yaxley 815C 15-ohm center-tapped resistor (red)
- 2 Durham 2 megohm 1-watt resistors
- 1 Durham 60,000 ohm 1-watt resistor (blue)
- 1 Carter sub-base rheostat
- 1 Durham 20,000 ohm 1-watt resistor (orange)
- 1 H & H 1565 on-off switch
- 1 5-lead battery cable, 54-in.
- 2 KK 817 brown wood knobs
- 3 Moulded binding posts
- 1 Set of hardware

Engineering Show Might Take Place of Annual Consumer Show

(Continued from page 82)

an engineering show would be received favorably, although I shall be much interested to see the results of any such movement as you may be able to imitate in this respect."

Walter E. Holland, chief engineer, Philadelphia Storage Battery Co., Philadelphia, Pa.: "Good idea to cut out consumer's shows, but there is no real need for an engineering show in my opinion. If held at all it should come about six months ahead of the June trade show."

J. W. Million, Jr., chief engineer, Bremer-Tully Mfg. Co., Chicago: "The logical program as followed by motors is new developments introduced twice a year. The automotive trade show is in January. The radio in June might well be July, I believe. Automotive improvements are introduced in August to stimulate sales in the declining fall period. New improvements in radio are and should be introduced in January to stimulate sales in the declining sales period. Engineering conventions and shows should precede such periods by two to three months."

F. J. Marco, chief engineer, Audiola Radio Co., Chicago: "It seems that if you hold such a show earlier than March (or February at the earliest) most parts manufacturers will not be ready with their new products. We have had this experience in the past, particularly with manufacturers of the larger units, such as tuning condensers, new designs of r. f. coils, etc. While I am sure that the engineering fraternity will be almost unanimous in its response favoring such a show, I wonder if it would be economic from the standpoint of the exhibitors. It seems to me that there would be almost as many exhibitors as potential customers, since there are certainly less than fifty radio manufacturers in the country who are quantity purchasers of parts."

Arthur Moss, president, Electrad, Inc., New York: "It is our opinion that a show of this type would be very valuable to the entire radio industry and should be held in the early part of November under the auspices of the I. R. E. and R. M. A. combined. The place should be carefully chosen preferably not in New York or Chicago but a location con-

venient to both. It, of course, will be essential to have suitable facilities for the show, for in my opinion this would be a very popular show. Would be very much interested in obtaining a report covering this entire matter.

R. H. Langley, director of engineering, Crosley Radio Corp., Cincinnati, Ohio: "I can see a considerably potential value in such a show provided it was properly managed and sponsored."

Henry G. Richter, vice president, Electrad, Inc., New York: "It is quite evident that two shows as outlined would be of great value to the industry. I believe that the most logical time for an engineering show would be in the early part of November because the engineers at that time, in my opinion, are laying the groundwork for their circuit design. This show, I think, should be held at some point convenient to the middle west and eastern parts and set manufacturers. Do not think it should be in Chicago or New York but at some place where the necessary arrangements could be made. This show should be held in my opinion under the auspices of the I. R. E. or the R. M. A. in conjunction with the I. R. E. Do not believe that the R. M. A. should have complete charge of an engineering show but it might be well for them to work with our engineering society on this matter"

In the following paragraphs we are indicating the opinions of the various engineers listed below. In each paragraph the date is shown first, next the city where the show might be held and last the organization under whose auspices it should be held.

How They Replied

K. E. Rollefson, Chief Engineer, National Electric Products Co., Chicago: (September or October) (Chicago and New York alternately) (R. M. A.)

A. A. Woods, Chief Engineer, All-American Mohawk Corp., Chicago: (First quarter) (Chicago) (R. M. A.)

A. Crossley, Chief Engineer, Howard Radio Co., South Haven, Michigan: (January) (Chicago or New York) (R. M. A.)

W. J. Schnell, Chief Engineer, Electrical Research Laboratories, Chicago: (January or February) (Chicago) (Parts manufacturers and engineering services.)

E. R. Stoeckle, Chief Engineer, Central Radio Laboratories, Milwaukee, Wis.: (December) (Chicago) (R. M. A. or I. R. E.)

W. D. Pack, Chief Engineer, Utah Radio Products Co., Chicago: (Not later than February 1st) (Chicago) (R. M. A.)

Roger Williams, Chief Engineer, Triad Mfg. Co., Inc., Pawtucket, R. I.: (May or before) (New York) (R. M. A.)

W. A. Ellmore, Chief Engineer, Carter Radio Co., Chicago, Ill.: (November) (Middle West) (R. M. A. or I. R. E.)

Roger M. Wise, Chief Engineer, Sylvania Products Co., Emporium, Pa.: (January or February) (New York) (I. R. E., R. M. A. or both.)

Leslie F. Curtis, Chief Engineer, American Bosch Magneto Corp., Springfield, Mass.: (March or April) (New York or Chicago) (R. M. A.)

E. E. Collison, Chief Engineer, Capehart Corp., Ft. Wayne, Ind.: (March) (Chicago) (R. M. A.)

R. L. Osborne, Chief Engineer, Dongan Electric Mfg. Co., Detroit, Mich.: (June) (Chicago and New York alternately) (R. M. A.)

Ford Studebaker, Chief Engineer, A-C Dayton Co., Dayton, Ohio: (December) (Chicago or Cleveland) (Engineering Division R. M. A.)

C. F. Wolcott, Chief Engineer, The L. S. Gordon Co., Chicago: (March) (Chicago) (R. M. A.)

Robert S. Doak, Chief Engineer, Premier Elec. Co., Chicago: (January) (Chicago) (R. M. A.)

F. E. Johnston, Chief Engineer, Amrad Corp., Medford Hillside, Mass.: (December or January) (Chicago or New York) (R. M. A.)



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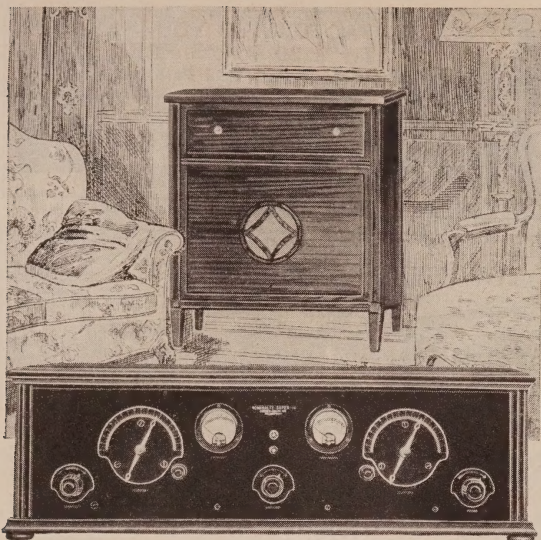
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*The Perfect
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This model—the finest radio engineers have yet conceived—is the outgrowth of long experience in building precision instruments for governments and professional operators.

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C. F. Stromeier, Chief Engineer, Cable Radio Tube Co., Brooklyn, N. Y.: (January) (Chicago) (R. M. A.)

David Wald, Chief Engineer, United Scientific Laboratories, Inc., New York: (January) (New York) (R. M. A.)

Nathan Goldman, Chief Engineer, Duovac Radio Tube Corp., Brooklyn, N. Y.: (March or April) (New York) (I. R. E.)

M. Bjerdal, Chief Engineer, c/o Hardwick Hindle, Inc., Newark, N. J.: (December or January) (New York) (I. R. E.)

V. A. Johnson, Chief Engineer, Supreme Instruments Corp., Greenwood, Miss.: (January) (Chicago) (R. M. A.)

R. H. Caldwell, Chief Engineer, Colin B. Kennedy Corp., South Bend, Ind.: (January) (Middle West) (R. M. A.)

C. C. Eickhardt, Chief Engineer, Igrad Condenser & Mfg. Co., Rochester, N. Y.: (November or December) (Chicago) (R. M. A.)

Geo. B. Horn, Chief Engineer, Dudlo Mfg. Co., Ft. Wayne, Ind.: (February) (Chicago or Pittsburgh) (R. M. A.)

Paul Hetenyi, Chief Engineer, Polymet Mfg. Corp., New York City: (March or April) (New York or Chicago) (R. M. A.)

E. S. Pridham, Chief Engineer, The Magnavox Co., Chicago: (April) (Chicago) (R. M. A.)

C. P. Mason, Chief Engineer, Stewart-Warner Corp., Chicago: (November) (Chicago) (R. M. A.)

N. C. Schellenger, Chief Engineer, Chicago Telephone Supply Co., Elkhart, Ind.: (May) (Chicago) (R. M. A.)

E. J. Doyle, Chief Engineer, Transformer Corp. of America, Chicago: (December) (Middle West) (R. M. A.)

W. A. Fricke, Chief Engineer, Yaxley Mfg. Co., Chicago: (April) (R. M. A.)

M. Heald, Chief Engineer, Thordarson Elec. Mfg. Co., Chicago: (February) (R. M. A.)

E. K. Oxner, Chief Engineer, High Frequency Laboratories, Chicago: (January) (Chicago) (Parts Manufacturers)

J. W. Million, Chief Engineer, Bremer-Tully Mfg. Co., Chicago: (October and March) (New York and Chicago) (I. R. E.)

R. H. Langley, Director of Engineering, Crosley Radio Corp., Cincinnati, Ohio: (January) (Cleveland) (R. M. A.)

Henry G. Richter, Chief Engineer, Electrad, Inc., New York: (November) (Middle West) (I. R. E. or the R. M. A. in conjunction with the I. R. E.)

F. J. Marco, Chief Engineer, Audiola Radio Co., Chicago: (February or March) (Chicago) (R. M. A.)

C. E. Stevens, Chief Engineer, Stevens Mfg. Co., Newark, N. J.: (April) (New York or Chicago) (R. M. A.—Good Idea.)

P. G. Andres, Chief Engineer, Temple Corp., Chicago: (January) (New York or Chicago) (R. M. A.—Excellent idea.)

D. E. Replogle, Chief Engineer, Jenkins Television Corp., Jersey City, N. J.: (January) (New York) (R. M. A.—Excellent idea.)

W. E. Holland, Chief Engineer, Philadelphia Storage Battery Co., Philadelphia, Pa.: (November) (New York) (R. M. A.)

Analysis of Choices

An analysis of the time when the engineering show should be held seems to indicate that January has the preference with thirteen choices, next comes March with six choices, then December with five and November with five.

Among the cities, Chicago seems to have first choice with seventeen, New York with seven and alternate New York or Chicago comes next with six, and no city specified being four.

As to the auspices under which the show should be held, the R. M. A. leads with twenty-nine, followed by the alternate R. M. A. or I. R. E. with three and the I. R. E. itself with two.

Tabulation

In the tabulation below may be seen the manner in which replies were received as to time, city and auspices.

TIME	CITY	AUSPICES
November	5 Chicago	17 I. R. E.
December	5 New York	7 R. M. A.
January	13 Cleveland	1 R. M. A. and I. R. E.
February	4 Chicago or New York	6 R. M. A. or I. R. E.
March	6 Chicago or Cleveland	1 Parts Manufacturers and Engineering Service
April	3 Chicago and New York	1 Not specified
May	2 (alternately)	
June	1 Chicago or Pittsburgh	
First Quarter	1 Not specified	
	Elsewhere	

With the Accessory and Parts Manufacturers

(Continued from page 109)

These small units are designed for rivet, one hole mounting directly to chassis member and will be furnished in two types, wire pigtail on one end, other end grounded or wire pigtails on both ends.

Compo Mfg. Co. is located at 217 W. Illinois St., Chicago, Illinois.

New Radio Course

AFTER years of preparation, research, study and investigation, the Radio and Television Institute now offers a radio course which has been pronounced by certain members of radio trades organizations to be of the very highest order, thorough, covering every branch of radio and representing just what is needed for making thorough service men.

Unique in the R. T. I. organization is what is known as the R. T. I. Round Table. This round table is made up of F. G. Wellmann, director of the school; F. H. Schnell, chief of staff; Allan C. Forbes of the Triangle Electric Company, in charge of the service end of the course; Homer Hogan, general manager of KYW, Chicago, in charge of the broadcasting division; Harold P. Manley, a prominent engineer, and Ira E. Rice, in charge of talking pictures.

This round table, which is beginning to draw considerable comment, meets regularly, when the big problems in radio are threshed out and new things are moulded in shape to be sent out to students. The round table keeps this training up-to-date. Its members include some of radio's brainiest men; and as a group they represent a great educational force, entirely new in the science of home study instruction.

The R. T. I. course also includes talking pictures, their installation, etc., and television. Television is slowly progressing and the time is coming when it will be the biggest thing in radio. That is why R. T. I. trains its students on the rudiments of television and keeps them up-to-date with its many new phases and developments.

Durham Has New Resistor

THE new unit recently designed by International Resistance, has an overall length of $\frac{5}{8}$ in. and a diameter of $\frac{3}{16}$ in., making it a very small and compact unit where space saving is essential and low power dissipation is in order. It is called type MF 4 $\frac{1}{2}$.

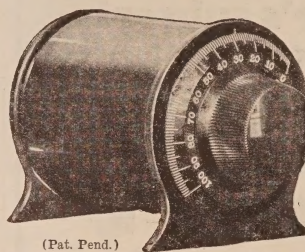
The unit is excellent for use in connection with faders, attenuation controls, and where a number of resistors are required for controlling the volume output of amplifiers used in theatre installations, radio sets, heavy duty amplifiers, etc.

The resistor is manufactured in all ranges from 100 ohms to 3 megohms, with wire leads two inches in length; has a normal rating of $\frac{1}{3}$ of a watt and is available for customer's requirements immediately.

Use a REESONATOR

TRADE MARK

for Sharp Tuning—Distance—Power
OVER 30,000 SATISFIED USERS



(Pat. Pend.)

\$4.75 COMPLETE

Not a wave trap

BRING your set up to date!

For all sets using an untuned floating or antenna tube, such as Atwater Kent Models 30-32-35-37-38-49, Crosley Bandbox, Radiola Models 16-17-18-51-33-333, Dayfun, Apex '28 Models and many others. Attaches across aerial and ground leads without tools in less than a minute.

It will enable you to tune sharper and plays with dance volume, stations which are barely audible or sometimes entirely inaudible without it. Requires tuning only when additional selectivity or power is required. Attractively constructed from hard rubber and bakelite in a highly polished rich mahogany color. Guaranteed against defects in material and workmanship for a period of six months.

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Try one for three days at our risk. If not thoroughly satisfied your money will be cheerfully refunded.

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Dealers—Over sixty Leading
Jobbers carry this item in stock.

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☐ I enclose check or money order for \$4.75 for which send me a Reesonator postpaid.

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☐ Send Dealers' Proposition.

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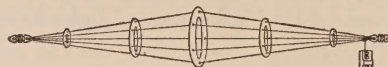
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Length 30 Ft.

Brings in Stations You Never Heard Before



Guaranteed Double Volume and Sharper Tuning

Assembled ready to string up. Brings in great volume, but retains the selectivity of a 30-ft. aerial. Rings are heavy gauge solid zinc. Duplicates in design and non-corrosive materials the aerials used by most of largest Broadcasting Stations. Design permits using this powerful aerial in 30-ft. space (preferably outside). Sharpens tuning of any receiving set because of short length but has enormous pick-up because 150 feet of No. 14 enameled copper wire is used. Made for owners of fine radio sets who want greater volume on distance without destroying sharp tuning. (Also used by many owners of short-wave outfits.) "Makes a good radio set better." Insurance approved Lightning Arrestor furnished. Price \$10.00

No. 60—Length 60 feet. Price \$12.50

Assembled ready to string up. "BIG BOY" size. (Same description as above, except that 300 feet of wire is used making this the most efficient and powerful aerial possible to manufacture.)

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SEND for our 1930 Wholesale Catalog. Filled with exceptional values in parts, kits, short wave kits, screen grid radios, push pull audio radio and consoles.

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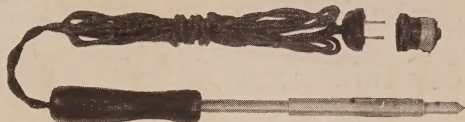
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The Famous WARD needs no introduction. Heating Elements will not burn out; either A. C. or D. C., 110-115 volts draws 100 watts. Six feet of heater cord, standard 2-piece separable plug, ebony finish handle, brass plated barrel, $\frac{3}{8}$ -in. diamond-shaped tip, temperature 500 degrees maintained, handle remains cool. Handle insulated against possible short. A genuine high-grade electric iron. Lava rock core approved and listed as standard by Underwriters' Laboratories.

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Can be used to solder anything
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New Junior Model Noise Eliminator

THE Insuline Corporation of America announces the development of an improved compact noise eliminator, for all-electric radio receivers, known as the new model Filtervolt, Jr.

The new Filtervolt, Jr., while retaining all the points of superiority of the original model, has been improved in a number of important respects. A recently developed filter system, operating on an entirely new principle of resonance, permits the use of much smaller condensers and chokes. This makes it possible to incorporate greatly increased noise eliminating properties in the same compact space. This method of filtering out line noises is the result of months of research work on the part of Alex G. Heller, chief engineer of the Insuline Corporation of America.

The Filtervolt, Jr., is particularly adapted for use in eliminating the more common disturbances from household appliances, such as vacuum cleaners, sewing machines, electric fans, electric heating pads, the switching "on" and "off" of electric lights, electric toasters, floor polishers, drink mixers, dial telephones and all appliances using small motors of one-sixteenth horse-power or less.

The application of the Filtervolt, Jr., to the radio receiver, is simplicity itself. It is merely necessary to remove the receiver plug from the house-current receptacle and plug the Filtervolt, Jr., in its place. The connection from the radio set is then made to a receptacle at the other end of the Filtervolt, Jr. No other controls are provided, nor are any further adjustments necessary. The receiver is turned on and operated in the usual way. In cases where the interference persists after the Filtervolt, Jr., has been put into the circuit, it is often possible to eliminate this by utilizing the extra binding post on the side of the device to make a ground connection. This is done by connecting a wire from the binding post to a steam pipe or a water pipe.

In some instances, better results may be obtained by placing the Filtervolt, Jr., between the source of current and the particular appliance which is causing the disturbing noises in the radio set. Of course, if the interference emanates from the antenna system, rather than from the a. c. mains, the Filtervolt, Jr., would not be effective, as this type of interference comes under the heading of "static." It is possible to check up on the antenna system, by tuning the set to a strong local station and removing the antenna and ground wires. If the crackling interference still persists, the use of the Filtervolt, Jr., is recommended.

Filtervolt, Jr., can be installed by any layman, however, since it is plugged in just like a floor lamp. It makes an ideal eliminator for every a. c. set owner, since the improvement in radio reception will be noticed and appreciated every day in the year.

Jefferson Announces Checker

A NEW and simplified tube checker for a. c. tubes has just been perfected by the Jefferson Electric Company, 1500 South Laflin Street, Chicago, after several years of experimentation and research. With only two readings, it is



possible to determine the condition of all popular makes of a. c. tubes.

The test is extremely simple. Place the tube in the proper socket and note the reading. Then press the small button and note the second reading. The difference between the two readings indicates accurately the amplification and the mutual conductance of the tube. The greater the difference in readings the greater the amplification.

Each tester is furnished with complete instructions, including a scale which will enable the user to determine whether the tube is good, fair, or poor. By other indications, it is possible to know whether the plate and grid are shorted, whether the plate is open, and whether the filament is open or shorted. The initial reading is an indication of the filament emission and plate resistance. The tester consists of six sockets, one each for the 226, 227, 224, 245, 171A and 280 type tubes, a milliammeter, a push button, and the connection for testing screen grid tubes.

The Jefferson a. c. tube checker is built to the high Jefferson standards. It is guaranteed against defects in material and workmanship.

Eby Takes Larger Space

THE H. H. Eby Manufacturing Co., Inc., formerly located at 4719 Stenton Avenue, Philadelphia, has moved into very much larger quarters right beside Shibe Park, the home of the World's Champion Philadelphia Athletics, at Twenty-second Street and Lehigh Avenue.

This change was made necessary by a substantial increase in the company's business during 1929, and plans for even greater expansion during 1930.

The Eby Company manufactures radio parts and is one of a group of parts manufacturers recently merged with the Utah Radio Company of Chicago.

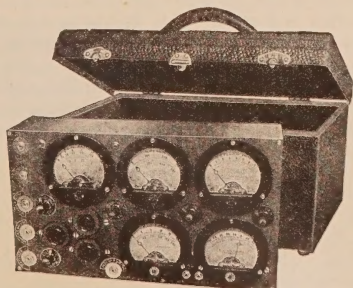
The Eby Company, which is the only eastern manufacturer in the group, will in future manufacture some of the products of the other merged companies for sale, distribution and warehousing in the eastern states.

With the Atwater Kent Company and the Philadelphia Storage Battery Company already located in Philadelphia, and with the concentration of all manufacturing activities of the combined Victor Company and Radio Corporation in Camden, Philadelphia is rapidly becoming one of the most important radio centers in the United States.

Hickock Has New Tester

ILLUSTRATED in this column is the Hickock Models SG-4600 radio set tester which consists of five Hickock instruments and two types of tube holders mounted in a solid bakelite case. The instruments are conveniently arranged and so interconnected that all circuits of all radio sets, whether using a. c. or d. c. tubes, can be quickly and easily tested.

The use of five meters in the SG-4600 radio set tester enables the operator to read all the circuits and functions of the radio set and the tube under test simultaneously. The plate voltage, heater or filament voltage, grid bias and plate current are



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Let me show you how to make big money right from

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C. F. HOLMES, Chief Engineer, Dept. T

Independent Electric Works

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FREE BOOK—Just Out



Filtervolt Jr.

\$3.00



will stop

those line noises
and clear up your reception

The New Model I.C.A. Filtervolt Jr. is a marvel of compactness. Newly discovered principles result in increased filtering capacity, built into a small unit.

Filtervolt Jr. gives quick and complete relief from line noises caused by vacuum cleaners, small motors, switching on and off of lights, etc.

Filtervolt Jr. may be plugged between current outlet and set or between current outlet and the apparatus that is causing the interference.

Every radio that is in any way suffering from line noises needs a Filtervolt Jr.

The demand for Filtervolt Jr. is so great that most dealers are now carrying it regularly in stock. In case your dealer can't supply Filtervolt Jr., send direct to us.

Filtervolt Sr. (\$15 list) is a heavy duty model and takes care of almost any A. C. line noise. Filtervolt Service Model (list \$7.50) is especially designed for trouble-shooting.

Send for latest I. C. A. Radio and Television Catalog

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Dealing With a House
That Can Give You
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"HiQ-30"



RADIO PARTS COMPANY
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HOTEL CENTURY

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Just Completed

350 ROOMS — 350 BATHS

This New Hotel contains every
modern appointment

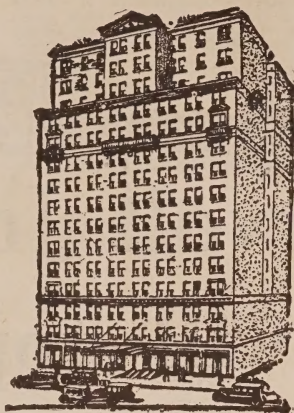
Every Room Has Private Bath

\$3.00 Per Day Up Single

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Situated in the heart of the city; near Railway Terminals.
All Leading Shops and Theatres within
a stone's throw.

JAMES A. FLOOD, Resident Manager



shown at one time, thus obviating the necessity of using push buttons or switches to get these four different readings on one meter.

The new SG-4600 model indicates simultaneously all the voltages and plate current entering screen grid tubes. Indicates the control and screen grid voltages simultaneously.

The use of a new type connector cable with 5-prong plug for connecting to set tester makes the operation of connecting the matter of a few seconds, also eliminates all liability of error.

The service man can more quickly and accurately service any set with the SG-4600 radio set tester employing five meters. The only switches to operate are those changing the range of the plate voltmeter, plate milliammeter and a. c. filament voltmeter. Usually in testing any individual set no change of switches is necessary as the switches may be set for the proper range of the instrument before the test is begun and the complete test may usually be made without further movement of the switches.

Mistakes are further guarded against by printing on the dial of each meter, the circuit which it measures, such as "plate volts," "a. c. filament volts," etc. This is only possible when a separate meter is used for each circuit. The liability of burning out or damaging any of the meters or tubes under test by operating the meters on the wrong scale is made impossible by the use of five meters.

The plate voltmeter incorporated in this device is a special high resistance type, having a sensitivity of 1,333 ohms per volt, which gives a resistance for the 300-volt scale of 400,000 ohms and for the 600-volt scale of 800,000 ohms. This instrument is so connected that it can be used either separately or in conjunction with the other instruments in making tests of circuits in radio receiving sets. To use this instrument separately, connect to the jacks marked "Positive 'B' battery" and

"Negative 'A' battery." The switch for changing the scale range is located at the right of the meter. The grid switch, located at the right of the grid voltmeter, should be set on position marked "— Fil."

The a. c. filament and line voltmeter is used only when testing sets using a. c. tubes. The scale ranges are 3.3 and 15 volts and are selected by means of the three-position switch located at the left of the meter. The meter is entirely disconnected from the circuits of the tester when the scale changing switch is set in the "0" or central position. When testing sets using d. c. tubes, this switch should always be in the "0" or central position, as this meter must be out of the circuit for all d. c. tests. To use this meter as a separate instrument, connect to jacks marked "Positive 'A' battery" and "Negative 'A' battery," setting the scale changing switch in the proper position for the voltage to be measured.

The 150 scale on this meter is used for measuring line voltage and is connected to line with the leads provided in which are permanently connected a suitable resistance. These leads should be connected to set tester by inserting the small plugs on the end of the cable into the jacks located above the meter. The other end of the cable should be inserted in line socket. Make sure that the scale changing switch is on the "0" position when reading line voltage. Do not leave the meter continuously in circuit when reading line voltage.

The d. c. filament voltmeter is the same type as the plate voltmeter and has a scale range of 15 volts. The sensitivity of this meter is the same as the plate voltmeter, viz., 1,333 ohms per volt, which gives a resistance for the 15-volt scale of 20,000 ohms. To use this meter as a separate instrument, connect to jacks marked "Positive 'A' battery" and "Negative 'A' battery," setting the a. c. filament voltmeter switch in the "0" or central position. The filament reversing switch should also be set on the left-hand position.

Tell 'Em You Saw It in the Citizens Radio Call Book Magazine and Technical Review

The d. c. filament meter is also used to indicate the control grid bias when testing sets using screen grid tubes. The insertion of the phone plug connected to end of the No. 6A adapter into the phone plug in tester entirely disconnects this meter from the filament circuit and connects same to control grid and cathode.

The grid voltmeter is a companion instrument to the plate and filament voltmeters and has the same sensitivity. The scale is 100-0-80 volts and the resistance 200,000 ohms. This high sensitivity allows the grid bias to be read correctly through the secondary of all audio transformers. To use this meter as a separate instrument, set the grid switch, located at the right of the meter, on the position marked "— Fil." and connect to jacks marked "Negative 'A' battery" and "Negative 'C' battery."

The plate milliammeter is of the double scale type, having ranges of 20 milliamperes on the low scale and 200 milliamperes on the high scale. The switch for changing the scale range is located at the left of the meter. To use this meter as a separate instrument use the jacks marked "Pos. B" battery and Neg. milliammeter.

Pierce-Airo Battery Chassis

PIERCE-AIRO, Inc., manufacturers of the well known Pierce-Airo a. c. chassis, announce the introduction of a screen grid battery chassis for which they report a considerable demand.

This battery chassis has three stages of radio frequency including one stage of screen grid amplification. It has an illuminated drum dial, compartment for B and C batteries, and is of rugged steel construction. The tubes required are one 222 screen grid and five 112-A power tubes. The manufacturers are Pierce-Airo, Inc., 117 Fourth Avenue, New York City.

Huge Sun Spots Presage Good Radio Conditions

GREAT activity on the sun visible from the earth as a 700,000 mile row of sunspots, has brought poor radio reception in recent weeks but it will probably be followed by a gradual return to the good conditions of 1923, Dr. Harlan T. Stetson, director of the Perkins Observatory at Ohio Wesleyan University here, declared in a statement to Science Service. He believes the recent solar disturbance probably represents the peak of the present eleven-year sun spot cycle. In collaboration with Dr. Greenleaf W. Pickard, radio engineer of Newton Center, Mass., Dr. Stetson has been studying the relation between sun spots and radio.

"The year 1930 should see a general decrease in solar activity, with a corresponding decrease in the ionization of the earth's atmosphere," Dr. Stetson declared. "This will favor the return of radio reception to normal conditions. During the subsidence period spasmodic outbreaks in the sun are to be expected at intervals, but with lessening intensity over the next five or six years.

"Scientists differ in their ideas as to just what happens when a broadcast wave travels over the earth. Some believe that an ether wave is propagated which is reflected back to earth from an ionized layer of the earth's atmosphere known as the Kennelly-Heaviside layer which lies some 70 kilometers above the earth's surface. Others maintain that the electric wave is refracted rather than reflected from such a layer.

"Whatever the mechanism, the wave appears to be turned back by this ionized layer of the earth's atmosphere. Any change in the intensity or degree of this ionization of electrification of the earth's upper atmosphere would have the effect of bending the ray more abruptly or less abruptly

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towards the earth and would at once be noticed in the intensity of radio reception. The more rapid changes of this sort are doubtless responsible for the phenomena of fading with which every radio fan is thoroughly familiar.

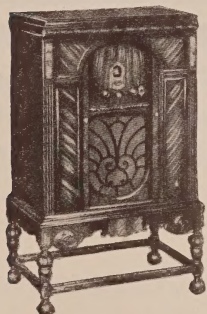
"According to our theory, the sun constantly bombards the earth's atmosphere with electrons or bundles of energy of high frequency which, in turn, tear apart the positive and negative charges of the atmospheric molecules. In other words, they ionize the atmosphere to a very considerable extent, thus producing the Kennelly-Heaviside layer. If the sun is more active on occasions, as when large spots appear on its surface, the degree of ionization increases, producing substantially the effect of lowering the Kennelly-Heaviside layer and upsetting the radio reception. When the sun is again less active, the atmosphere tends to return to its normal state of ionization and radio broadcasting reception tends to improve as the ionized layer lifts.

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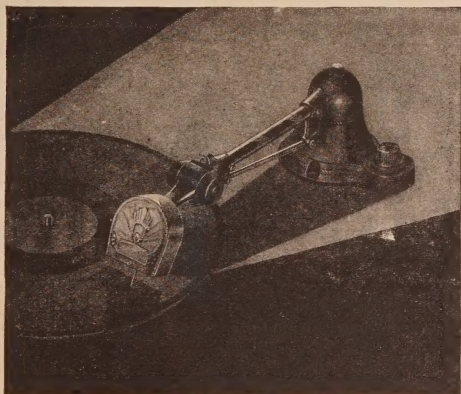
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Upco Electric Pickup

THE Upco electric pickup has been designed to meet, in a practical way, the exacting requirements of sound reproduction from records. Splendidly uniform frequency response throughout the useful audio frequency range of from 5000 to 50 cycles together with its high voltage output more than sufficient to meet the demands of any amplifier condition insures an amazing fidelity of reproduction and tremendous volume range.

The pickup structure embodies many mechanical features which combine their beneficial effects to make this unit the general standard of comparison. Its graceful, beautifully finished structure is supported laterally and vertically on hardened steel balls—developing an effortless, almost frictionless response to the complex record variations. This complete freedom in mechanical action minimizes record wear and objectional needle-scratch.

The pickup armature is cushioned and balanced in an ingenious manner which provides a remarkably free needle action without sacrificing the slightest degree of stability. This



unit bears a very enviable record of remaining in adjustment.

Securely mounted in the base of the Upco pickup structure is a sturdy, non-inductive constant load volume control whose resistance taper is so graduated as to secure perfect output from the merest whisper to full, crashing volume.

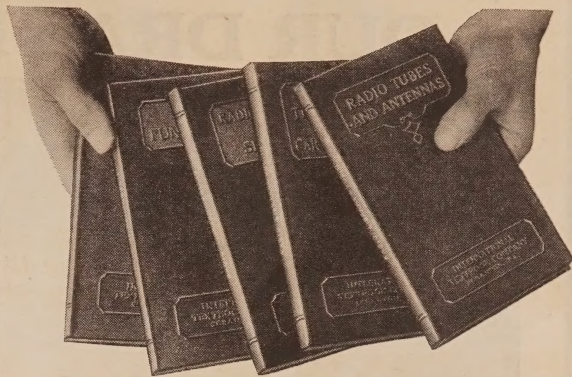
In addition to phonograph service types, the Upco electric pickup is assembled in a theatre model, similar in structure to the standard types and of sufficient overall length to operate with the sixteen-inch records of talking picture work.

To provide a splendidly practical link between the acoustic phonograph and the radio, the Upco Pickup Type D is designed to be mounted upon tone arms in place of the acoustic sound box of old. Supplied with a volume control mounted in a black bakelite housing, it connects to the first audio stage of the radio set, thus enabling one to reproduce his phonograph records electrically through the radio loud speaker.

Vacuum Tube Produces Artificial Radium Rays

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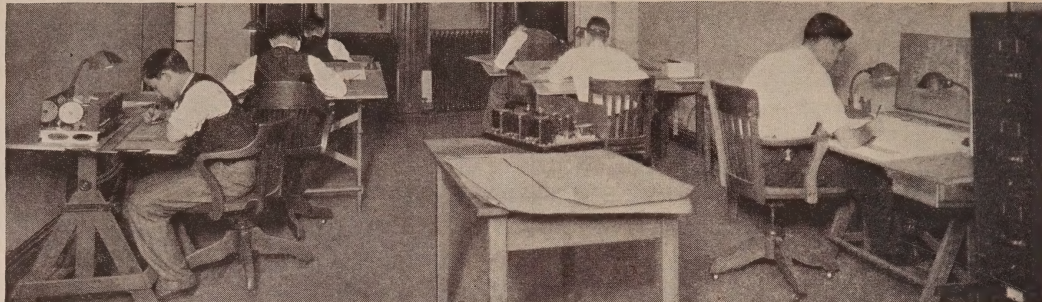
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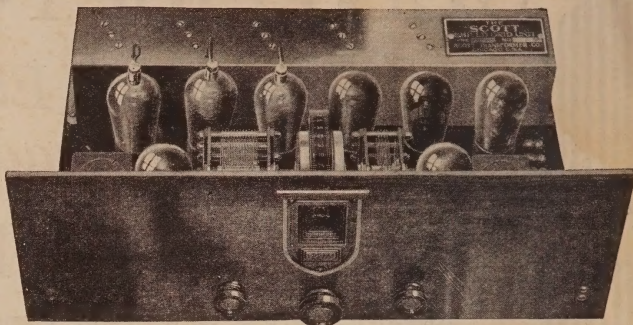
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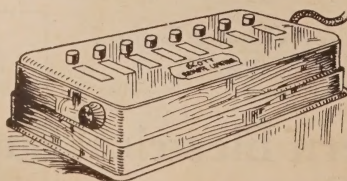
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